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ART. LVII.—*On the Physical Structure and Hypsometry of the Catskill Mountain Region;* by ARNOLD GUYOT, Princeton, New Jersey.

IN a former paper on the physical structure of the Appalachian system, I noted the fact that, though extending through the most populated and civilized part of the United States, that system of mountains was still among the least known of our country. This remark applies with double force to the Catskill Mountain region.

Situated in the old and flourishing State of New York, only one hundred miles from its metropolis, in full sight and within a few miles of the great artery of travel, the Hudson River; visited every summer by thousands of tourists in search of the beauties of nature and of the cool air of its high valleys and plateaus, its real mountain region has been thus far almost a sealed book to the geographer and the geologist as well as to the transient visitor. It seems a matter of legitimate surprise that to this day no physical map of the Catskills, deserving the name, could be found. True, there are county and township maps which trace with tolerable accuracy the water courses, the roads, the villages and the scattered farms; but they all end with the cultivated portions of the valleys and leave the mountains either in blank or give them in very inaccurate and unintelligible outlines.

For one, however, who has visited that part of the country, with the view of studying its physical conformation, the cause of the sad condition of its cartography is no mystery. The whole region was originally an unbroken forest, and, with the

exception of the bottom and slopes of a few valleys and of some portions of the northeastern plateaus, it has remained so to this day.

The wilderness of the Adirondacks is more extensive but hardly more complete than that of the pathless forests of the Southern Catskills, the habitual haunts of numerous bears, wild cats and occasional panthers. Add to this the fact that most of the mountain tops, not to say all, are not sharp peaks, but extensive thickly wooded flats from which no distant views can be obtained and it may readily be understood what difficulties lie in the way of the topographer and why ordinary surveys stop short of the mountain chains.

And still several features of the Catskills are well calculated to excite in a high degree the curiosity of the scientific investigator, and to call for a thorough study of its plastic forms. Though situated in the midst of the Appalachian system, and evidently a part of it, it appears in it as an anomaly. While the Appalachian ranges, throughout the system, invariably trend from the southwest to the northeast, all the chains of the Catskills run in an opposite direction from the southeast and east to the northwest and west.

I have shown elsewhere in this Journal, the existence of transverse chains, in the Appalachians of North Carolina and Georgia, reaching 5000 and 6000 feet between the Blue Ridge and the Great Smoky Mountains. But these two great border-chains at least retain the normal direction, while, in the Catskills, even the border-chains run at right angles to the system. Again, while the neighboring Appalachian chains, the Kittatinny, or Blue Mountains, in New Jersey, hardly reach 1800 feet, and their continuation, the Shawangunk, rarely exceed 2000 feet (Sam's Point 2341), the group of the Catskills suddenly rises to double that height. On the east, beyond the valley of the Hudson, the Green Mountain ranges remain lower by 1000 and 1500 feet. On the north, beyond the deep valley of the Catskill Creek, the plateaus average less than 2000 feet and on the west the swells of land, around the sources of the Delaware and Susquehanna, do not much surpass that average, their highest points seldom reaching 2400 feet. The Catskills stand as a mighty citadel overtowering by 2000 feet all the surrounding country.

These apparent anomalies in the otherwise regular structure of the Appalachian system need an explanation. The first step toward it was to obtain a correct idea of the topography and orography of the region, and of the direction and altitude of its mountain chains and valleys, which no existing map could give. To this work the writer has devoted several summer vacations, from 1862 to 1879. The results of these observations are

mostly embodied in a map, now engraved* which is believed to furnish the first accurate delineation of these mountains. A few words on the manner in which these results have been obtained may not be amiss here.

The map, of which Plate XIX gives a reduced sketch, was drawn by my assistant, E. Sandoz, and engraved on the scale of one inch for three miles. It covers a surface of about 4000 English square miles, of which the mountainous part proper occupies somewhat more than one half, or about 2400 square miles. The position of all the mountain peaks was obtained by means of a theodolite and a sextant, both reading to a minute of a degree; the points of the triangulation of the Coast Survey along the Hudson River serving as a base.

From the nature of the case none but natural signals could be used; but the very large number of "tours d'horizon" observed from every prominent point, with profiles regulated by angular positions, render errors of any consequence extremely improbable. I was, therefore, hardly surprised, but much gratified, to find that the position of the only point the map has in common with the triangulation of the New York State Survey, the Utsayantha, near Stamford, though determined entirely independently, was in close accordance with that assigned to it by this carefully conducted survey.

The Hydrography was taken from the most recent county and township maps of Greene, Ulster, Delaware and Schoharie counties and has been regulated by the position of the mountains.

The altitudes have been measured by mercurial barometers with the aid of assistants, all trained by myself; in only a few of the less important points the aneroid was used to obtain a preliminary measurement. Among my most useful assistants I must mention E. Sandoz for all the Northern Catskills, Wm. Libbey, Jr., for observations and computations in the Southern Catskills, John Reid and Samuel E. Rusk for the eastern portions. Most of the aneroid observations I owe to H. Kimball, the most indefatigable and skillful mountain climber of the Catskills.

The formula used in the computations is, as in my other measurements, that of Laplace, in connection with a table of corrections for the influence of the hour of the day and the barometrical coefficient, which I have derived mainly from the elaborate reduction of the meteorological observations of Geneva and St. Bernard by Plantamour.

The altitude of five points, not more than ten miles apart, was determined with great care from the Hudson River and the Delaware and Ulster Railroad, and each served as a base for

* The map is for sale by Charles Scribner's Sons, and B. Westerman, New York City.

the measurement of the neighboring heights. They are "the Vista," at Haines' Falls, for the east, Molyneux's farm for the southern Catskills, Lexington Village and Windham Center for the central region and Vaughn's Highland House for the north and west. They have been tested by reciprocal observations among themselves. The altitudes are reduced to the mean tide level in New York harbor, assuming this to be about 2½ feet below mean tide in the Rondout and Catskill Creeks.

The name Catskills is said to have been given to this wilderness by the first settlers, who were of Dutch origin, on account of the numerous wild cats inhabiting its forests. To the same settlers are due the geographical appellations of *kill* for stream, *clove* for gorge, and *vly* or *vlaie* for swamp, so frequently met with in the Catskills. The boundaries of the region to which the name applies, however, are not well defined. But confining it between the Hudson River and the sources of the Delaware, from east to west, and the Catskill Creek and the sources of the Navesink and Rondout Creeks, from north to south, we enclose the mountain district which has the special characters above indicated; and this is the portion comprised in the new map. It must be said, however, that the inhabitants of the plateau region north of Catskill Creek, to the Helderberg Mountains and west to the sources of the Susquehanna, claim to be still in the Catskills.

The mountain region is divided by the Esopus Creek into two groups differing considerably in their physical structure, one on the north, the northern or Catskills proper, situated mainly in Greene county; the other on the south, the southern Catskills or Shandaken Mountains, in Ulster county.

The *Northern* or *Catskills proper*, between the Esopus and Catskill Creeks, form a massive plateau having the shape of an irregular parallelogram, extending from S.E. to N.W., and shut up between two high border chains, ten to fifteen miles distant from each other, running about in the same direction. The southwest border is formed by what may be called the central chain of all the Catskills, the other by the northeast border chain. The southeastern end is closed by the short chain of the High Peak; the northwestern by the high swell of plateaus which divide the headwaters of the Delaware and Susquehanna from those of the Schoharie Creek and the Hudson. Inside of this highland three secondary ranges, starting from the northeast border chain and running nearly west, almost to the foot of the central chain, fill the inner space, enclosing deep valleys in which flow the waters of the Schoharie Creek and its tributaries.

The only access to this interior highland is through the deep and wild gorges called cloves, of which there are but few; all

renowned for the picturesque beauty of their torrents and cascades, and for their ice caves.

A striking peculiarity of the plastic forms of the northern Catskill group is that while its western end is, as it were, buried in the general plateaus of western New York, its mountains rising but moderately above their surrounding base, its eastern end stands isolated on three sides by deep and broadly open valleys, projecting, in all its height, as a mighty promontory, to within ten miles of tide water in the Hudson River.

The very base of its mountains rarely exceeds 600 feet above tide. The altitude of Woodstock at the base of the Overlook Mountain is 594 feet; the entrance of the Plaaterkill Clove, at West Saugerties, 660 feet; the entrance of the Kaaterskill Clove, 600 feet; Kiskatom, near the foot of the North Mountain, 687; Acra, not far from the base of Blackhead, 546 feet; Cairo, 347 feet. No wonder that the aspect of the Catskills is no where more imposing than from the Hudson River and the surrounding lowlands, from which their whole height is seized at a glance, and that it has been thus far believed that the highest points were found among the mountains of the eastern end. It is thus that the Round Top of the old geographies, now called the High Peak, at the head-waters of the Schoharie Creek, retained for over half a century the undeserved reputation of being the culminating point of the Catskills. This deception was common even to the inhabitants of the interior, and nothing but actual measurement could convince them of their error.

The panorama of mountains, viewed from Catskill village, extending from the Overlook Mountain, on the south, through the High Peak, the North Mountain, Black Head and Windham High Peak, is not a single chain, but rather the eastern end of the border chains together with that of the short range bearing the High Peak, which rises between the two. It is, therefore, but the abrupt termination of the whole mass of the Highlands toward the great gap to the Hudson Valley, as a description of the orographic structure of the plateau will show.

To make this description clear, a few preliminary remarks on the general geological structure of the Catskills, and the characteristic features of their topography seem to be desirable. We have not to look in the chains of the Catskills for a series of anticlinal and synclinal folds or arches, or fragments of arches, as in ordinary mountain chains. Throughout the region the strata of which they are composed are nearly horizontal from the bottom of the valleys to their top, or have a dip rarely exceeding four or five degrees. The same is true of the plateaus.

The mountains, therefore, whatever be their external forms, as well as the surrounding plateaus, are masses of piled up strata, with a slight inclination to the south or southwest and northwest, often hardly perceptible. A greater disturbance from the horizontal position is seldom observed and, when found, is only local. To this disposition of the strata and their tendency to break by the joints at right angles to the planes of stratification we must trace the occurrence of those abrupt ledges which are so frequently encountered by the traveler, and are often a cause of serious difficulty and no little danger to the inexperienced mountain climber. This also explains why the tops of the mountains are not pointed peaks but mostly flat surfaces, often of considerable extent, and why it is only at the edges of these that are found the perpendicular ledges which border precipices of vertiginous depth and disclose the splendid views which have rendered the Catskill Mountain House and the Overlook Mountain so celebrated. To the same cause, again, and to the peculiar mode of disintegration of the strata by successive steps, are due the numerous cascades which are so characteristic of the Catskills, and one of their greatest attractions.

Most of the peaks measured were, as usual in American wildernesses, without names. I had to find some fitting appellations. Those in use, such as Roundtop and High Peak, North and South Mountains, are so often repeated in all parts of the Catskills that to prevent confusion it was sometimes necessary to change or to qualify them. In the new ones I tried to avoid the fanciful names so much in vogue, and to derive them when possible from their geographical location. To Roundtop at the head of Little Westkill I applied the old Indian name of the region, Ontiora. Roundtop at the head of Drybrook became Doubletop, a name which from its form is more appropriate; South Mountain close to it is called on the map Graham Mountain, in honor of its owner, one of the old settlers of that district. In the Catskills nearly all valleys and passes are called *hollows*.

The *Central Chain* is, as before mentioned, the longest, the most massive, and plays the part of a back bone for the whole Catskill region. It forms at the same time the southwestern border chain of the Northern Catskills. Its total length from the Overlook Mountain, its southern end, to the Utsyantha, near Stamford, its northwest termination, is somewhat over thirty-five miles. Its direction is not uniform: in the first half to the Deep Hollow gorge its trend is west-northwest; at that point it turns sharply to the northwest. It descends in long slopes and heavy spurs toward the south and west, while it falls abruptly toward the interior to the northeast.

The central chain is divided into four, almost equal, portions by three deep gorges or cloves which give access to the interior valleys; the Stony Clove, summit of road 1700 feet, reaching the Schoharie basin near Hunter village; the Deep Hollow, summit 1973 feet, near Westkill, and the Grand Gorge Railroad depot, 1570 feet, near Moresville.

1st. The first part, from the eastern end to the Stony Clove, is about ten miles in length. It begins with the Overlook Mountain, and turning north reaches the Plaaterkill Mountain with which it forms a horse shoe having its convexity to the east and enclosing to the west the valley of the Sawkill with Shue's, or Echo, lake at its head.

From the Plaaterkill Mountain it stretches 20° north of west to the Stony Clove, along the valley of the Plaaterkill and Schoharie Creek. The prominent points from east to west are the Indian Head, with three peaks increasing in height toward the west, followed by the two Schoharie peaks rising from one mass, the higher one on the northwest of the other; then comes the Mink Mountain, with a broad rounded shape and a prominent projection to the north; still beyond is the long, flat, table-like Stony Mountain which falls by precipitous ledges into the Stony Clove. The flat summit of the last is so regular that the measurements of six points along the ridge did not show a difference exceeding a score of feet. Except for the Overlook, I found no current names for these various well-defined mountain tops. Those which I here propose are mostly suggested by their position.

The Plaaterkill Mountain is at the south entrance of the Plaaterkill Clove. Indian Head was a name given to me by an old hunter of the locality. The Schoharie Peaks are at the head of Schoharie Creek. Mink Mountain borders the Mink Hollow of the old settlers; and Stony Mountain is next to Stony Clove.

The altitudes, as shown in the following table, increase regularly westward to Hunter Mountain.

TABLE.

Overlook Mountain,	3150	Schoharie Peak, N. W.,	3650
Plaaterkill "	3280	Mink Mountain,	3807
Indian Head, East peak,	3380	Stony Mountain, East end,	3844
" Middle peak,	3510	" Center,	3823
" West peak,	3581	" West,	3789
Schoharie Peak, S. E.,	3583	Hunter Mountain,	4038

Two passes cross this first part of the chain, the Indian Pass, from the head waters of the Schoharie and Plaaterkill, east of the Indian Head, to the Sawkill valley and the Overlook, the elevation of which is 2694 feet; and the Mink Hollow, between the Mink and Stony Mountains, with a wood road whose summit is 2629 feet. This last is said to be the trail by which the

first settlers gained an entrance into the interior of the Catskills; for, though being over 900 feet higher than Stony Clove, it is more easy of access than that wild and rocky gorge. Stony Mountain sends to the southwest a high, massy spur of considerable elevation, between the Stony Clove and the Beaverkill, where it bears the name of the Oleberg, or Olderbargh Mountain.

The Overlook Mountain, on the southeast, and the South Mountain, near the old Mountain House, on the northeast, are two great promontories of the Northern Catskills, both terminating in perpendicular ledges; two natural observatories, from which the most extensive views are obtained over the broad valley of the Hudson, the chains of the Highlands and the Green Mountains. The Overlook can boast besides of a fine panoramic view of the high chains of the Southern Catskills.

The second portion of the central chain, between the Stony Clove and Deep Hollow, a distance of 10 miles, is composed of two chains and contains the culminating points of the whole. It begins, on the east, by the broad mass of the Hunter Mountain, the highest point of the Northern Catskills, 4038 feet. This sends to the north a long and rocky spur terminating opposite Hunter village in the precipitous and rocky ridge bearing the name of the Colonel's Chair, 3037 feet. It expands similarly to the southwest into a broad ridge. To this is attached the Westkill chain, which, from its direction and greater altitude, may be considered as the true continuation of the central chain; while the Lexington chain attached to the northern spur is but a secondary feature. Between these two chains lies the deep valley of the Westkill, nine miles long, with the abrupt sides of the mountains turned toward it. The Westkill chain, like the Stony Mountain, descends toward the southwest in long and gradual slopes which look more like an inclined plateau deeply furrowed by a few narrow valleys, such as the Peck Bushkill valley, the Broadstreet and Forest valley, the Ox Clove; all tributaries of the Esopus. This, in truth, is the outer margin of the north Catskill plateau. The Lexington chain, between the Westkill and Schoharie Creeks, falls abruptly on both sides.

The altitudes of both ranges decline regularly from Hunter Mountain westward, but more rapidly in the Lexington chain, which terminates rather suddenly in the Lexington Flats; while the Westkill chain retains its preëminence and continues the main chain. In the last the Big Westkill rises to 3896 feet and at the west end the Deep Hollow Mountain still measures 3500; while in the Lexington range Rusk Mountain is only 3626 and Lexington Mountain, at the west end, 2930 feet. The gaps in these two chains are indentations

without depth. Jones' Gap, between Hunter and Rusk Mountains, is the only one through which a wagon road passes. The Broadstreet Gap, in the middle of the Westkill chain, has hardly more than a mountain trail. The Hollow Tree Gap, near Hunter Mountain, and Peck's Gap, in the western half, are even less accessible. All this district between the Stony Clove and Deep Hollow gorge, the Esopus and Schoharie Creek, is still one of the wildest and least known of the Catskills.

The third part of the central chain, between the Deep Hollow and Grand Gorge, is the longest—11 miles—but its elevation gradually diminishes. Its general direction changes abruptly, at the Deep Gorge, from west 10° north to north 30° west. It begins on the east by the Beech Ridge with a slightly undulating top reaching in the Vlaie Mountain 3531 feet; is depressed in the Halcott Gap to 2725 feet, beyond which it rises again to the height of 3545 feet in the Bear Pen. It somewhat declines in Pond Mountain and the Ontiora, or Roundtop, at the head of the little Westkill, 3458 feet, and terminates by Jones Mountain, hardly lower than Ontiora, and the Irish Mountain near Grand Gorge.

Ontiora deserves a special mention for the great beauty and extent of the view it affords from its summit.

It is one of the two or three mountain tops which are free from trees. From this high observatory the eye takes in at one glance almost the totality of the Catskills including the Slide Mountain on the extreme south; High Peak and Black Head, on the east; Windham High Peak, Pisgah and Ashland Pinnacle, on the northeast; Utsyantha, on the northwest; and the innumerable hills of Delaware county, on the west and south. It has besides the merit of being easy of access by a well graded road from Prattsville and Batavia Kill, passing within half a mile of its summit at an elevation of 3180 feet.

This portion of the central chain unlike the preceding one has, on its southwestern slope, long and broad valleys—the Halcott Bushkill, Batavia Kill and Roxbury—whose waters form the east branch of the Delaware; and between which are ridges, sometimes full as high (such as the Red Kill Mountain 3540 feet) as the main chain with which they are connected.

The northeastern, or interior, slope is much less abrupt than in the Westkill chains. The only indentation of importance is the valley of the little Westkill.

The fourth and last division of the central chain, from Grand Gorge to Utsyantha, six miles, begins with the Bald Mountain near the Grand Gorge Depot of the Ulster & Delaware Railroad, continues by the slightly higher chain of the Moresville Mountains and, beyond a gap of moderate depression, terminates suddenly in the Utsyantha Mountain, near Stamford, with

an altitude of 3203 feet. This is also nearly the height of the Moresville range.

Utsyantha, at the head of the West branch of the Delaware, may be considered as the end of the Catskills in this direction; beyond it all high mountains disappear and the chains lose themselves in plateaus which increase in height on all sides. The following table shows the regular decline from Hunter Mountain to the end of the chain.

TABLE.

Hunter Mountain,	4038	Utsyantha,	3203
Big Westkill,	3896	*Lexington Range.*	
Deep Hollow Mountain,	3500	Rusk Mountain,	3626
Vlaie Mountain,	3531	Beeline Mountain,	3300
Bear Pen,	3545	Pine Island Mountain,	3086
Ontiora,	3458	Lexington Mountain,	2930

From the foregoing description it will be seen that, if we connect the mountain tops along the central chain by an ideal plane, it will gradually rise from the east end one-quarter of the distance to Hunter Mountain and thence descends still more gradually to the northwest end, no local peaks interrupting its normal slopes. The two ends, the Overlook Mountain, 3150 feet, and Utsyantha 3205 feet, are nearly equal in altitude.

Hunter Mountain is by far the most remarkable in the whole range. It is owing to its broad massive form, with no well defined peak rising from its uniform summit, that its superior height was not discovered nor even suspected by the inhabitants of the valley, while the High Peak looming up, isolated and in full view from the Hudson, gained a reputation for preëminence though, in fact, nearly 400 feet lower.

2d. *High Peak Range.*—High Peak, or the old Roundtop, so long celebrated as the culminating point of the Catskills, is the highest part of a short range running between the two head branches of the Schoharie Creek, parallel with the central chain and connecting it with the northeast border chain. Its mass fills all the space between the Plaaterkill and Kaaterskill Cloves, in the depths of which it falls in precipitous slopes, adorned by leaping cascades. On the east it descends more gently in terraces toward the plain. Its summit is capped, as many others in the Catskills, by thick layers of a hard conglomerate, which, having better resisted the destructive agencies of the atmosphere, stand distinct as a round head nearly 800 feet high, on the broad shoulders of the mountain, and suggested its first name, which ought to have been retained. The direction of this range is west 30° north; its length only six miles. High Peak, its eastern end, rises to 3664 feet; a second peak, hardly a mile distant to the west, now called Roundtop, is still 3500 feet; but farther on the chain descends rapidly, termina-

ting in Clum Hill, 2372 feet, near the confluence of the two branches of the Schoharie Creek.

From its central position this last hill affords a most instructive panorama of the interior chains.

3d. The northeast border chain appears more like the outer wall of the Highlands, falling from the top of the mountains to the valley of the Catskill Creek. Though its general direction is to the northwest, the individual parts show a succession of alternate north and northwest trends.

From the South Mountain, near the Catskill Mountain House, to the North Mountain the direction is north; from North Mountain to Black Head, northwest; from Black Head to Acra Point, north; from Acra Point to Windham High Peak, west 30° north; from the last point to East Windham Gap, northwest; from the Gap along Mt. Zoath, due west; from Zoath, through Mt. Hayden, Pisgah and the northwest terminal chain, northwest again.

The altitudes along that chain follow the same order as in the central chain opposite, but are somewhat lower. South Mountain at the Star Rock, near the Coast Survey Signal, is 2497 feet; North Mountain, east end, 3285 feet, and its highest point 3442; Black Head, the highest of the range, 3945; Acra Point approximates to 3085 feet; Windham High Peak, 3534; Mt. Hayden, 2900; Pisgah, 2905; in the terminal range Sutton Hill, 2573 feet; High Knob, 2654; Barlow Hill, 2651 feet; Leonard Hill, 2649 feet.

Here again, as in the central chain, a general plane carried through the summits would show a comparatively rapid rise to Black Head, one quarter of the distance, and a much more gradual descent from Black Head to its termination. As in the central chain the two ends, east and west, the South Mountain, 2497 feet, and Leonard Hill, 2649 feet, have about the same altitude. It would be still more alike if instead of the Star Rock, on the border of the ledges, we took the real culminating point of South Mountain, a short distance farther west.

The general slopes of the border chain toward the valley of the Catskill Creek are steep, rarely less than 25° to 28°; but reaching the foot of the mountains, they change quickly to gentle undulations descending by a slope of 6° to 8° to the Catskill Creek, making the valley very broad and open. In the interior the slopes are equally steep, but much shorter, as the bottoms of the valleys are 2000 feet and over above the sea-level. The passes which afford an entrance into the interior valleys are about as high as in the central chain. In Pine Orchard, the Catskill Mountain House lies 2225 feet above tide; the Summit House, in East Windham Notch, 1940 feet

in the northwest terminal chain, Sutton Gap, 2236 feet; Potter's Hollow Gap, 1966 feet; Bennet's Notch, 1997 feet.

4th. The highland between these two main chains has, as remarked before, the shape of an irregular parallelogram. Its length is about twenty-seven miles; its width, between the Plaaterkill and South Mountain, only six miles. It increases to ten miles between Stony Mountain and Black Head, reaches its maximum—fifteen miles—between Deep Hollow and Pisgah, and is reduced to 12½ miles between Grand Gorge and High Knob. The central part is filled by three ranges, separated by valleys in which flow the tributaries of the Schoharie Creek: 1st. The Eastkill and East Jewett Range starting from the North Mountain and running a few degrees north of west, 12½ miles long; 2d. The Black Head Range, from Black Head due west, continued by the West Jewett Range, sixteen miles long; 3d. The Pisgah Range running west 10° south, a distance of ten miles.

The Eastkill and East Jewett Range, between the main Schoharie Creek and the Eastkill, is divided into two parts by the Parker Notch, 2415 feet. The first detaches itself from the North Mountain, 3442 feet, and descends rapidly to the Star Rock of Parker Hill, 2545 feet. The second to the west rises again to 3190 in the Eastkill Mountain, and 3146 in East Jewett Mountain; both north of Hunter village, on either side of a deep notch.

The Black Head Range runs from Black Head nearly due west for five miles, gradually descending to the Big Hollow Gap road. Its great height, its massive forms, its fine rounded summits, whose aspects vary from every new point of view, make it the most conspicuous of these inner chains and a prominent feature of the landscape. The central part, the long and symmetrically shaped Black Dome, attains the height of 4003 feet. It is cut off from its neighbor Black Head with its steep and rocky slopes, by the Lockwood Gap, 3446 feet; while the following peaks to the west: Mt. Kimball, 3960; No. 4, 3566, and No. 5, as yet nameless, are only separated by slight depressions.

Between the Big Hollow and Henson Gap roads, 1800 feet, rise two rounded hills, 2500 feet high, cultivated to the top, and from which one of the most varied and extensive panoramic views of the Catskills may be obtained. On the same line, farther west, the Jewett Range has an altitude of 3025 feet, at its culminating point, just above Windham Center; and of 2931 feet in the conical Tower Mountain, above Ashland. This Black Head Range, with its continuation, separates the valleys of the Eastkill and Bataviakill, the two main tributaries of the Schoharie Creek.

The third and most northern of these transverse chains begins at Mt. Pisgah, 2905 feet, and stretches west 10° south for about ten miles between the Bataviakill and the Manorkill. Unlike the others it grows in altitude westward. Next to Pisgah the wooded summit of Richmond Peak is 3202 feet high; Strawberry Knob, 2975, and Sister Mountain, 3002 feet; while Ashland Pinnacle, with its 3420 feet of elevation, rivals the high peaks of the central and border chains. The two slopes are very unequal. On the south they descend gently, almost plateau-like, for five or six miles to the Bataviakill; on the north they fall rapidly to the Manorkill Valley, reaching the same level within a mile from the ridge.

Beyond the Manorkill, both on the east and west side of the deep Schoharie Valley, the high mountain chains disappear. Plateaus from 1500 to 2000 feet of elevation become the prominent feature. The series of hills, of 2650 feet, forming the northwest end of the border chain, hardly rise more than 500 or 600 feet above their apparent base, and soon lose themselves in the surrounding plateaus, before reaching the valley of the Schoharie.

On the west side of the valley a long and high swell of land, starting from the Utsyantha, near Stamford, stretches directly to the north, dividing the waters of the Schoharie from the head waters of the Delaware and Susquehanna, and joining the plateaus which border the Mohawk River. North of Stamford this table land bears a group of hills, among which Mine Hill, the highest, measures over 2800 feet. Wood Chuck and Potter Mountains are but little lower. Farther north the plateaus culminate in Summit at the height of about 2400 feet.

Drainage.—A glance at the map will teach still better than any description that the interior highlands of the Catskills proper are drained, from beginning to end, alone by the Schoharie Creek and its tributaries. They thus form a unique hydrographic basin.

It is true that the Kaaterskill derives the main part of its waters from the inner amphitheatre formed by the South Mountain, the ridge on which stands the Mountain House, and the North Mountain Outlook, at the bottom of which they collect in the Catskill Lakes; but this can scarcely be regarded as an exception; for after a course of not much more than a mile they suddenly leap into the deep gorge forming the beautiful cascade of the Kaaterskill and joining the other branch which descends from Haines' Falls, their rivals in wild beauty, they hurry together in rapids through precipitous chasms out of the mountains. The whole distance from Haines' Falls, at the head of the valley to its outlet, at Palenville, is only three miles. The same may be said of the Plaaterkill Creek, which flowing from

the Indian Head precipitates itself almost immediately into the deep clove bearing its name, from which its roaring waters issue only two miles below. Both properly belong to the outside slopes.

The main Schoharie Creek originates at the foot of the Schoharie peaks, near the head of the Plaaterkill Clove, from which it is hardly separated by a slight swell in the swampy valley bottom. It follows closely the foot of the central chain and receives just below Tannersville its first affluent, also coming from swampy meadows near Haines' Falls, at the head of the Kaaterskill Clove; these two head streams embracing the chain of the High Peak. The creek, keeping the direction of the central chain to the west-northwest, flows through Hunter village 1609 feet to Lexington, 1320 feet, where it turns with the chain to the northwest, to the mouth of the Beaverkill Creek, beyond Prattsville, 1164 feet.

Here it leaves the central chain and, running almost due north to the confluent of the Manorkill, it enters the mass of the northwestern plateaus, cutting from Gilboa 1033 feet, to Middleburg 640 feet, a deep and narrow valley, the bottom of which is from 1000 to 1300 feet below the general level of the country it traverses, while the occasional flat bottoms in it at Blenheim, Breakabeen, Fultonham and Middleburg, rarely attain more than half a mile in width. Its course from Blenheim, through Middleburg, Schoharie and Central Bridge, where it receives the Cobbleskill Creek, is alternately to north-northeast and north. From this place, instead of following the broad valley through which runs the Albany and Susquehanna Railroad, it leaves it and cutting its way at right angles through the high hills which border the Mohawk, it finally enters that river near Fort Hunter, after a course of over seventy-six miles.

All the main tributaries of the Schoharie Creek in the mountain region, the Eastkill, the Bataviakill, the Manorkill, come from the northeast border chain and flow almost due west toward the central chain, on the opposite side, where they enter the main creek; the Eastkill, three miles above Lexington, the Bataviakill just above Prattsville, the Manorkill at Gilboa. Like most valleys of erosion they offer, in their upper and middle course, a succession of flat and open basins from which they fall through narrows, in rapids and cascades, into the valley of the main creek. The left affluents from the central chain, the Westkill, Little Westkill and the Beaverkill, are all inconsiderable in length and volume. In the region of the plateaus another Westkill, on the west, at Blenheim, and the Keyserskill on the east, at Breakabeen, are hardly more than mere torrents.

The contrast of the broad open valleys between the mountain chains above described, and the narrow and deep cut of the Schoharie Creek when passing through the plateau region is a feature to be noted.

This drainage which sends the waters of the Catskills all the way around to the Mohawk to come back by the Hudson, after a course of 175 miles, to within 10 miles of their starting point is certainly remarkable, and betokens a very peculiar physical structure. This is made more striking by the fact that on both sides of these highlands the waters of the valleys of the Catskill and Esopus Creeks flow, as we might have expected, from the western plateaus directly to the Hudson River. These three streams, which are so near each other, flow in opposite directions, and it seems as if this plateau of the Catskills had been lifted up on its eastern part to a higher level from which its waters were sent in the opposite direction.

From the nearly horizontal position of the strata which is common to the mountains and the surrounding plateaus and from the peculiar features of the drainage, we are led to admit that the plastic forms of the Catskill region are the work of the erosive forces which have been so long active since the time of their first upheaval. Neither of these mountain chains, the central no more than the transverse ranges, have the character of anticlinal axes of elevation, nor are the valleys synclinal folds. These orographic features therefore are not due to the ordinary dynamic process which has folded and shaped into southwest and northeast mountain ranges, the other portions of the Appalachian system, and do not constitute an exception to the rule. The idea of a series of axes of elevation, the principal of which is prolonged on the northwest to Little Falls, on the Mohawk, and is often represented as connecting the Catskills with the southern chains of the Adirondacks, has thus no foundation whatever in nature. The nearly continuous heights, up to 2000 feet and more, which form the water-shed between the Schoharie Creek, the Mohawk and the various branches of the Susquehanna are but the swelled border of the plateaus falling rather abruptly into the Mohawk valley. We may, therefore, conceive the original form of the Catskills to have been that of a high plateau, a mass elevation, forming a part of the Appalachian plateau region which extends west of the Alleghanies from South Virginia, and fills nearly all the western portion of the State of New York, south of Lake Ontario and the Mohawk River. The lowest altitude of the primitive plateau is marked by the ideal plane which would pass through the mountain tops, and its superior elevation on the east would account for the flow of the waters, the gradual scooping out and the sloping of the valleys in the direction

they now have. This may also explain the possibility of the creek, below Prattsville, cutting through the western plateau a thousand feet higher than its level, when we conceive that the erosion was begun by a stream coming from a higher level than the present plateau.

The Southern Catskills are far from having the regular features which characterize the Northern group; nor are the boundaries as well defined, except along the Esopus valley. The central mass containing the most continuous and elevated chains, from which flow the head waters of the Esopus on the north and of Navesink and Rondout Creeks on the south, occupies the townships of Shandaken and Denning. It is flanked on the east by several high chains running north and south, in Olive, and on the west by long ridges, extending to the southwest and northwest into the Delaware Basin, in Hardenburg. The extent of this mountain tract from the Esopus at Olive City to the Delaware near Margaretville, at the end of the Drybrook ridge, is 25 miles; its width from the Esopus at Shandaken to the southwestern boundary of Denning is about 16 miles.

We find here no interior plateau enclosed between high border chains. The massive central chain, which bears the highest summit is accessible from all the surrounding valleys without crossing any high pass; but the roughness of the wild mountain torrents and the unbroken primitive forest make that access anything but an easy task. Though the direction of the main chain is about the same as in the northern Catskills, viz: west-northwest and northwest, several important ridges run to the north and northeast, almost at right angles, a direction never found in the first group, and imparting considerable irregularity to the physical structure of the Southern Catskills.

The main chain, beginning with the Slide Mountain, stretches west 22° north for 8 miles to the broad knob of Eagle Mountain, from which it turns at right angles, north 30° east, 4 miles to Balsam Mountain, and changes again, beyond the Lost Cove, to north 40° west in Belle Ayre where it terminates. The first two parts form a dark, high, unbroken wall of 12 miles, densely wooded, crossed by a single wood road, in the Big Indian, or Helsinger Notch, 2677 feet. Few summits rise much higher than the general crest. They are, from east to west, the Slide Mountain 4205 feet, Hemlock Mountain, Spruce top 3567 feet, Fir Mountain, about the same height, Eagle Mountain 3560 feet, Balsam Mountain, south end, 3601 feet. Belle Ayre has a milder aspect and descends to 3394 feet in its highest portion.

The Slide Mountain, the culminating point of the Southern, and the highest of all the Catskills, is in many respects quite remarkable. It terminates abruptly on the northeast toward the deep valley of Woodland, or Snyder Hollow, showing signs

of a slide of fallen rocks which suggested its name. From its broad triangular top it sends a ridge toward the southeast, which divides the waters of the Esopus from those of the Rondout, and terminates in the Lone Mountain 3670 feet, by which it is almost connected with the Wittemberg chain. Another high ridge descends toward the south and nearly reaches the high group of Table Mountain 3865 feet, and Peak-o'-Mouse 3875 feet, which separates the head waters of the Rondout from those of the East branch of the Navesink. It thus becomes the main hydrographic center of the region, sending its waters to the northwest by the Esopus; northeast to the same by the Woodland Creek; south by the Rondout to the Hudson; southwest by the Navesink to the Delaware. At 500 feet from the top, steep ledges, suddenly breaking the evenness of the ridge, mark the base of the cap of hard Subcarboniferous conglomerate (No. 10 of the 1st Pennsylvania Survey, according to James Hall) which crowns the king of the Catskills. An easy ascent is found by taking the road from Big Indian to the Helsinger Notch, from which the ridge, just beyond the Navesink waters, leads to the top by a regular and gentle slope.

On the east several chains not yet well studied run from the neighborhood of the Slide between the Woodland Creek and the middle course of the Esopus. The most important is the rough chain of the Wittembergs. The highest points are from south to north, Cornell Mountain, 3681, near Lone Mountain and on the line of the Slide; Friday Mountain and Great Wittemberg 3778 feet. Further to the east, and south of Shokan, High Point, celebrated for the beauty of its panorama, rises almost isolated from a low ridge to the altitude of 3098 feet.

Between the Slide and Balsam range, on the south and west, and the Wittemberg chain, on the east, lies the central plateau of the Pantherkill, 7 miles wide each way, wild and wooded, entirely surrounded by the waters of the Esopus and the Woodland Creek. It is surmounted by a long ridge running nearly due north from Slide Mountain with two prominent peaks, the highest of which, the Pantherkill Mountain, rises to an altitude of 3828 feet. It is deeply scooped out by torrents which pour their waters, on the west directly, and on the east by the Woodland Creek, into the Esopus.

On the southwest of the angle formed by the Fir and Eagle Mountains, but hardly connected with the main chain, rise two mountain peaks of still greater altitude, Graham Mountain, 3886 feet, and Double Top, 3875 feet, called respectively, by the few settlers South Mountain and Round Top. I have already said that my reason for changing these names was to avoid the confusion arising from their frequent repetition. These two high peaks, closely connected together, are situated,

in regard to the main chain, as Table Mountain and Peak-o'-Mouse are at the east end, south of the Slide; and both groups are of the same elevation. The Graham Mountain group is a remarkable hydrographic center sending many branches to the Delaware; the Drybrook and the Millbrook to the north and west; the Beaverkill and Navesink west branch to the southwest and south. Graham Mountain is also the head of a long ridge in which reappears the normal trend of the Appalachian chains, which is also indicated by the course of the Navesink and of the upper Rondout Creek. But all that region lies beyond the pale of my observations and requires further investigation.

What was said above of the Geological structure of the Northern Catskills is true of the Southern group.

Notwithstanding the greater variety of its plastic forms, which would, at first sight, indicate considerable dislocations, the nearly horizontal position of the strata, which predominates except in a few and limited localities, forbids the belief that they were the ruling element in their formation. The mountain chains are no anticlinals, nor are the valleys synclinals. Erosion and slow disintegration seem to have been the main efficient causes of the conformation of the surface.

If we reconstruct in imagination the original plateau from which these orographic features have been sculptured, by passing a plane through the principal heights, we shall find a law very much like that observed in the Northern Catskills. From High Point, at the eastern border of mountain land, 3098 feet, the plane passing through Lone Mountain, 3670, reaches in the Slide its maximum, 4200 at 7 miles, one third of its total length. It thence descends more gradually through the Eagle Mountain, 3500 feet, down to Belle Ayre, 3400 feet, 14 miles, or two-thirds of the entire distance.

Why it is that, notwithstanding the similarity of general structure, the streams in the Southern Catskills should have taken an opposite course and shaped themselves into an entirely different system, is not easy to say. The absence of border chains and of the eastern projection, so characteristic of the northern group, may partially account for this difference.

Primitive, and perhaps later, dislocations, even when in the shape of simple cracks, may have had a share of influence in bringing about the result. Traces of the great diluvian glaciers are found in abundance throughout the Catskills; but I have seen, in Switzerland, too much of the action of glaciers on the ground over which they move, to attribute to that latest of geological agencies any great influence on the fundamental features of the present topography of the mountains.

I am fully aware that to solve such problems and answer the

geological questions raised by the topographical features, indicated in this paper, requires a careful and exhaustive stratigraphical study which it was impossible for me to undertake while the arduous topographical and hypsometrical work demanded all my time and attention. This must remain for future investigation. Meanwhile, however, I will add here a few preliminary suggestions.

The masses of rocks forming the Catskill Mountains were deposited in a gulf of the Devonian Sea comprised between the Adirondack plateau and the Green Mountain range, including the low Silurian ridges between the Hudson and the foot of the Catskills, all of which were probably emerged when the Devonian age began. Most of New England was also above the level of the ocean. The thickness of the sediments shows that the bottom of this gulf gradually subsided during that time to a depth of some 5000 feet, constantly making room for new deposits.

The presence of the gray conglomerate capping the highest hills proves that the deposition of these sediments continued into the Subcarboniferous period, after which they were upheaved above the level of the ocean, before the deposit of the Coal-measures, and have remained emerged ever since.

The slight southward dip indicates that during the Devonian age a general and gradual rise of the continent took place from the north, which raised successively above water parts of the Lower and Upper Silurian, in the Helderberg and Oriskany sandstone, which were laid dry when the Catskill sandstones and shales were still depositing.

The most notable upheaval of the Catskill region probably took place at the time of the great revolution which raised the main Appalachian system; doubled the size of the early continent and closed the Carboniferous age. But the peculiar situation which sheltered it from the immediate effect of the force which was in play, the lateral pressure arising from the sinking of the bed of the Atlantic, modified the hypsometric form of that portion of the western plateaus.

A glance at the sketch (Plate XIX) will show that, when this great Appalachian upheaval began, the domain of the Catskills was secluded from the ocean by large tracts of preëxisting lands; the Adirondack plateau on the north, New England and the Green Mountain ranges on the east which, though affected themselves in a measure, served as a barrier against a strong action of the upheaving force from those quarters on the region beyond. Farther south, however, no obstacle intervening, the force was free to display its full power; and to this cause, I am inclined to attribute not only the folding of the numerous Appalachian chains, but also the remarkable

bend westward of the whole system, in Pennsylvania, as well as the significant fact that it is in the prolongation of the axis of that convexity that the western plateaus beyond swell to their greatest average height, in the region of the sources of the Susquehanna, Alleghany and Genesee Rivers. To this pushing northwest and northward of the land, and its reflex action northeastward, the swelling of the plateaus of western New York may be, in great measure, attributed. The Catskills would thus have been subjected to a pushing action, from three or four opposite directions, by the rising lands: From the Adirondack plateau on the north, from the Green Mountains on the east and from the rising Appalachians on the southwest and south; and hence, perhaps, their superior elevation above all the surrounding lands.

On the other hand, it might be supposed that the covering of the hard Subcarboniferous conglomerate, which must have been general in the Catskills, protecting the underlying strata of the Catskill formation against denudation, prevented their being swept away, as in the surrounding region, and thus preserved, in a greater measure, their primitive elevation. But the known facts hardly warrant more than a surmise.

In a very interesting paper published in the Proceedings of the American Association for the Advancement of Science, in 1875, James Hall announces, as the result of four years' observation of two of his assistants, the existence in the Catskills of four lines of anticlinals, nearly parallel to each other and running from the southwest to northeast in conformity with the ordinary trend of the Appalachian ranges; the synclinals occupying the summits, the anticlinals the bottom of the valleys. As the map and sections accompanying the paper have not been published, I cannot locate them, but one of the synclinals passes through the Slide Mountain. Notwithstanding the great difficulty of determining such stratigraphical changes in so rough a country when the dip varies but a few degrees, I am quite disposed to acknowledge the reality of a fact observed with so much care. But if the trend of these axes is what it is said to be, far from coinciding with the chains and valleys, they cross them almost at right angles, and were probably posterior to the scooping out of the valleys and mountain chains, on the conformation of which they had so little effect. They were the last effort of the forces which have shaped the main Appalachians.

A hypsometric feature which may refer to this order of facts is that the three maxima of altitudes, above 4000 feet, the Slide Mountain, Hunter Mountain and Black Dome, are situated in a straight line, trending from southwest to northeast.

The short descending plane from this line eastward, which

we have noticed as belonging both to the northern and the southern group, may be due to a subsequent subsidence of the Great Hudson Valley.

This valley during the Champlain Epoch of the Quarternary age was an arm of the sea. The east end of the Catskills was then a series of high marine bluffs, worn out by the action of the waves, which would explain the abruptness of their eastern termination.

I need not repeat that I consider the above suggestions as mere hints for future investigation.

I here add a classified list of most of the points mentioned, reduced to the ground above mean tide level in New York harbor. *B.* means a measurement by mercurial barometer, *Aner.* by aneroid, *P.L.* by pocket level.

	Northern Catskills.	Feet.
B.	Half-way House	286
B.	Palenville—Union Church	470
B.	Entr. of Kaaterskill Clove	609
B.	Palenville Hotel, lower bdg.	680
B.	Morefalls bridge	883
B.	Lakecreek bridge	1217
B.	Haines' Falls, Chas. Haines	1890
B.	Vista, Aaron Haines' Porch	1932
B.	Bridge, Miles Haines	1906
B.	Dixon's Hill	2045
B.	Kiskatom	687
B.	Sleepy Hollow	1290
B.	Catskill Mountain House	2225
B.	Catskill Lakes	2140
B.	Laurel House Piazza	2038
B.	W. Saugerties, Quarrybank	660
B.	Head of Plaaterkill Falls	1855
	Schoharie Creek—Main Valley.	
B.	Headwaters Schoharie Cr'k	1900
B.	Mulford's Summit House	2043
B.	Tannersville Hotel	1926
B.	Hunter Village, Rusk's	1609
B.	Lexington Bridge	1320
B.	Westkill Village	1538
B.	Prattsville Hotel	1164
B.	Gilboa Hotel	1036
B.	North Blenheim, Bridge	800
B.	Breakabeen, Creek	743
B.	Fultonham, Church	714
B.	Middleburg R. R. Depot	640
	Schoharie Creek—Tributaries.	Feet.
B.	Peters Farm. East Kill.	2100
B.	Jewett Heights, Church	1810
	Valley of Batavia Kill.	
B.	Big hollow, Church	1758
B.	Hensonville, Cross road	1646
B.	Union Society, Bloodgood	1670
B.	Windham Center, Hotel	1510
B.	Asland Center P. O.	1435
B.	Redfalls P. O.	1270
	Valley of Catskill Creek.	
B.	Cairo	346
B.	Acra	546
B.	Cornwallville	950
B.	South Durham	969
B.	West Durham	1884
B.	Durham Center	850
B.	Oakhill Bdg., Catskill Creek	609
B.	Cooksburg	756
B.	Preston Hollow	870
B.	Livingstonville	1100
B.	Franklinton	1260
B.	Potter's Hollow	870
B.	Smithton	1268
B.	Highland House, Piazza	1857
B.	Broome Center, Hotel	1973
B.	Makee's Corners	1964
	Central Chain.	
B.	Woodstock, Hotel	594
B.	Mead's House	1789

		Feet.
B.	Overlook Mountain House	2978
B.	Overlook Mountain	3150
B.	Plaaterkill Mt.	3280
B.	Indian Pass	2694
B.	Indianhead, East Peak	3380
B.	" Middle "	3510
B.	" West "	3581
B.	Schoharie East Peak	3583
B.	" West "	3650
B.	Mink Mountain	3807
B.	Mink Hollow, summit road	2629
B.	Stony Mt. East end,	3844
B.	" " Center	3823
B.	" " West end	3789
B.	Stony Clove, approximate	1700
B.	Hunter Mountain	4038
B.	Colonel's Chair, N. end	3037
B.	" " Highest	3165
	Lexington Range.	
B.	Rusk Mt.	3626
Aner.	Evergreen Mt.,	3624
Aner.	Bee line "	3300
Aner.	Pine Island "	3086
Aner.	Lexington "	2930
	Westkill Range.	
B.	Big Westkill Mt.	3896
PL.	Deep Hollow Mt.	3500
B.	Deep Hollow, Summit road	1973
B.	Beech Ridge Gap	3096
B.	Vlaie, or Fly Mt.	3531
	Halcott Gap, Sum. Road	2725
Aner.	Bearpen Mt.	3545
	Summit road to Batavia K.	3180
B.	Ontiora, Little West Kill	3458
B.	Utsyantha Mt. near Stamf.	3203
	Chain of Highpeak.	
B.	Highpeak (Old Roundtop)	3664
B.	Roundtop	3500
B.	Clum Hill	2372
	North Border Chain.	
B.	South Mt., near Mt. House	2497
B.	Palenville Overlook	1660
B.	Sunset Rock	2115
B.	Point of Rocks	2178
B.	North Mountain, Outlook	3100
B.	" " East Peak	3285
B.	North Mountain, W., Stopel	3440
B.	Blackhead	3945
PL.	Burnt Mt.	3170
B.	Windham Highpeak	3534
B.	Grand View Hotel	1970
B.	Cade Mountain	2390
B.	Summit House	1930
P.L.	Hayden Mt.	2960
B.	Pisgah	2905
	East Jewett Range.	
B.	Parkerhill, Star Rock	2545
B.	Parker Notch	2415
P.L.	East Kill Mt.	3190
B.	East Jewett Mt.	3146
	Blackhead Range.	
B.	Blackhead	3945
B.	Lockwood Gap	3446
B.	Black Dome	4003
B.	Kimball Mt.	3960
B.	Westpeak, No. 4	3566
Aner.	Delong Mt.	2540
Aner.	Henson Gap, Summit road	1989
Aner.	West Jewett Mt.	3025
B.	Tower Mt.	2931
	Pisgah Range.	
B.	Pisgah	2905
B.	Richmond Cone	3202
B.	Sister Knob	3002
B.	Ashland Pinnacle	3420
	Northwestern Catskills.	
B.	Sutton Gap, road	2235
B.	Sutton Hill	2573
B.	Potter's Hollow Gap, road	1964
B.	Koni or Pine hill	2337
B.	Bennet Notch	1994
B.	High Knob	2654
B.	Best Hill	2649
B.	Barlow Hill	2651
B.	Gordon Gap, road	2504
B.	Gordon Hill	2629
B.	Leonard Hill	2649
B.	Manorkill	1520
B.	Stone Bridge	1382
B.	Strykersville	1215
B.	Platt Creek Church	1683
Aner.	Mine Hill	2810

SOUTHERN CATSKILLS.

		Feet.
B.	Highpoint	3098
B.	Peak o' Mouse	3875
B.	Table Mountain	3865
B.	Dominie Hammond's House	1945
B.	Lone Mt.	3670
B.	Cornell Mt.	3681
B.	Wittemberg Mt.	3778
B.	Woodland, N.W. Beach's H.	1140
B.	Pantherkill Mt.	3828
B.	Slide Mt.	4205
B.	Helsinger Notch	2677
B.	Sprucetop	3567
B.	Eagle Mt.	3560
B.	Balsam Mt., South End	3601
B.	" " North End	3571
B.	Belle Ayre Mt., max.	3394
B.	Graham Mt.—Dry Brook	3886
B.	Doubletop	3875
B.	Segar's house—Dry Brook	1923
B.	Molyneux House Porch	1315
B.	Guigou's Boarding House	1439
B.	Pine Hill Village	1512
B.	Undercliff	2200
B.	Rose Notch	2743
B.	Birch Kill Notch	2334
B.	Monkey Hill (Mucky)	2489
B.	Halcott Mt.	3504

Elevations above highwater of Rondout, by levels of the Ulster & Delaware Railroad; communicated by Geo. Coykendall, Supt.

Rondout	2	Shandaken	1069
Kingston	155	Big Indian	1209
West Hurley	540	Summit	1886
Olive-Branch	511	Griffins' Corners	1516
Brooks Crossing	525	Dean's Corners	1344
Brodhead's Bridge	500	Halcottville	1399
Shokan	533	Strattons' Falls	1456
Boiceville	598	Roxbury	1497
Mount Pleasant	690	Grand Gorge	1570
Phoenicia	790	Stamford	1767
Fox Hollow	996		

ART. LVIII.—*Recent Explorations in the Wappinger Valley Limestone of Dutchess County, N. Y.;* by Professor W. B. DWIGHT, Vassar College, Poughkeepsie, N. Y. With plate XXI.

NO. 3.—DESCRIPTION OF A NEW DISCINOID BRACHIOPOD FROM THE TRENTON AT NEWBURGH, N. Y.

IN a recent article on a locality of Trenton limestone at Newburgh, N. Y.,* the writer mentioned his discovery of a new "Discina" at this spot, reserving its description till a more thorough study could be made of it. I am happy to acknowledge my indebtedness in this examination to the cordial and very valuable assistance of Mr. R. P. Whitfield, especially in resolving the internal characteristics.

It has become evident that its features remove it from the genus Discina, to which I had at first referred it, the chief points of distinction being the position of the peduncular groove in the more conical valve, while in Discina it occurs in

* This Journal, January, 1880.

the less conical one, and, more especially, the marked difference in the character of the muscular impressions.

It is quite possible that it represents a new genus, but I will refer it provisionally to that one of the Discinoid genera to which it seems the more closely related.

*Orbiculoidea** *conica*, sp. nov.—Shell black and flinty, suborbicular; longest diameter 12^{mm} or less; eminently lamellose in character. Ventral valve highly conical, varying from a quite regular cone with a slightly flaring margin, to a lower cone with widely flaring margin, and sometimes assuming subcylindrical and gibbous forms; apex pointed, sub-central, elevated in many specimens $\frac{1}{2}$ a diameter or more above the marginal plane; peduncular groove ovate, extending from $\frac{1}{3}$ to $\frac{1}{2}$ the distance from the apex to the margin, foramen at the wider part, i. e. at the end most distant from the apex. Dorsal valve either nearly flat, slightly convex, or somewhat concave; apex from $\frac{1}{4}$th to $\frac{1}{3}$d of a diameter distant from the nearest part of the margin; and very slightly elevated.

Both valves are marked exteriorly by fine regular concentric ridges, 100 to an inch near the margin, 150 to an inch on the general surface, but rapidly increasing in fineness around the apex to 250 to an inch, and there becoming very shallow or entirely disappearing as shown in plate XXI, figure 8.

These ridges are often sharp, giving a serrated outline to a cross section in much weathered individuals, but in such as are well-preserved, they are smoothly rounded, as are also the valleys between, but slightly steeper on the apical side.

In the best specimens of the internal markings of the flatter (dorsal) valve, there is a deep marginal pallial impression, and there are two large well-marked pyriform muscular impressions nearly central, diverging toward their broader portions posteriorly, leaving a V-shaped tract between, which is often marked by a central line or fissure. There are apparently faint traces of two additional and smaller muscular impressions between the above and the posterior margin and near to the latter; these are however very doubtful. The internal character of the conical ventral valve cannot be satisfactorily discovered from any of the specimens on hand.

This fossil is remarkable for the position of the foramen at the distal extremity of the peduncular groove—and still more for its marked crania-like arrangement of muscular impressions.

I have found it only in a small tract of rock mostly at one end of the exposure of Trenton, which I described in my last paper as exhibited 2$\frac{3}{4}$ miles north of Newburgh, N. Y.; but hundreds of fragments of this fossil are lying in close contiguity within four or five hundred square feet of surface. The speci-

* D'Orbigny.

mens are so exceedingly brittle as to render them difficult of extraction without injury, and as to require great caution in the handling after they are secured. Of the ventral valve, I have found but four or five sufficiently perfect to show the peduncular groove; of the dorsal valve I have obtained twice as many which are fair specimens. The comparison of the many fragments, and of cross sections exhibited in broken rock, has served to confirm what is indicated in the more perfect individuals. In no instance have the two valves been found united, nor has it been possible to obtain an equally satisfactory exhibition of the general surface of both sides of the same individual valve; for the action of acid in separating the imbedded side from the rock is apt to flake it off injuriously. The margins of the specimens are almost invariably in a broken state.

The shell has been above described as lamellose. I have not been able to detect any punctate structure. In some cases, especially in weathered specimens, the external ridges assume a minutely tuberculous character, apparently due to delicate radiating lines of internal structure more than of external form, which may be detected in certain individuals crossing both the ridges and the inter spaces; these enable the points at which they cross the ridges to resist weathering more than the adjoining parts. In most cases, however, nothing but the simple concentric lines of the ridges are visible.

EXPLANATION OF PLATE.

Figures 1, 2 and 3.—Apical portions of the lower (ventral) valve of three different individuals, actual size, showing the peduncular groove. No. 3 shows a tendency toward a cylindrical form.

Figure 1 *a*.—A view of specimen figure 1, enlarged 2½ diameters, to show the shape of the groove, the position of the foramen (at *f*,) and the strongly marked concentric ridges.

Figure 4.—Another lower valve, actual size, exhibiting a broadly flattened margin, to the diminution of the height of the apex.

Figure 5.—The largest lower valve yet found; nearly a regular cone; the marginal edge wanting; (actual size.)

Figure 6.—A fragment of an upper (dorsal) valve, actual size, showing the apex and considerable concavity of the surface between the apex and anterior margin.

Figure 7.—A nearly perfect and very flat specimen of the upper valve showing the apex slightly elevated and about ¼ diameter from the nearest margin.

Figure 7 *a*.—Same, magnified two diameters to show concentric ridges.

Figure 8.—A cross section through a portion of the upper valve, extending from the apex at *a*, a short distance toward the anterior margin, magnified nine times, showing the laminations of the shell and the character of the ridges.

Figure 9.—A cross section of upper valve, near posterior margin, parallel to the shorter diameter.

Figures 10 and 11.—Interiors of upper valves of two individuals, actual size, showing clearly the pallial impression and one pair of muscular impressions with some indications of a second pair near the posterior margin (lower part of the figure.)

Figure 11 *a*.—An enlargement, two diameters, of specimen figure 11.

Figure 12.—An ideal profile of the two valves united and in position.

ART. LIX.—*The Color Correction of certain Achromatic Object Glasses;* by Prof. C. A. YOUNG, Princeton, New Jersey.

THE recent discussions in this Journal upon the theory of achromatism will perhaps give interest to a brief statement of the results actually obtained in practice. I accordingly present the results of my measurements upon two excellent object-glasses which have come under my observation.

The first is that of the Dartmouth College Equatorial, made by the Clarks in 1871. It has an aperture of 9·36 inches and a focal length of 12 feet. It is considered by the makers a little under-corrected, but suits my own eye very well, in pleasant contrast to the violent over-correction of a 6-inch Munich glass which I had used for several years previous. The spherical aberration is very perfectly corrected. The curves are essentially those of Littrow (Mem. Roy. Astron. Soc., vol. iii), a nearly equiconvex lens of crown, and a nearly plano-concave flint.

The other lens is that of the Equatorial belonging to the observatory of the John C. Green School of Science at Princeton. It has an aperture of 9·5 inches and a focal length of 138. It is constructed substantially upon the curves proposed by Gauss (Gauss' Werke, vol. v, p. 507, Göttingen Ed.), the radii and constants of the objective being as follows, viz:

		Inches.
Crown lens, meniscus, convex side outward	Radius of convex surface,	16·572
	Radius of concave surface,	57·425
	Thickness at center,	0·620
	Interval between lenses,	0·312
Flint lens, concavo convex, convex side next crown,	Radius of convex surface,	20·684
	Radius of concave surface,	13·871
	Thickness at center,	0·305

The radii were determined by a delicate spherometer.

The telescope is remarkably excellent in every respect, especially in the darkness of the field and the power of exhibiting faint objects, like the satellites of Mars and Uranus.

The observations on the Dartmouth telescope were made by myself in 1872; those on the Princeton instrument in 1879, partly by myself and partly by my assistant, Mr. McNeill. The number of observations on the Princeton telescope was from ten to twenty for each line of the spectrum examined; the figures for the Dartmouth instrument depend upon only five measurements each, and are of course somewhat less reliable.

The method of observation was in all cases substantially the

same. The spectroscope, arranged as for observation of solar prominences, is attached to the telescope, which is first pointed at the center of the sun. The portion of the spectrum to be examined is then brought to the middle of the field of view, and one of the longitudinal dust-lines (caused by particles between the jaws of the slit, always far more abundant than one would like) is made perfectly distinct by the focussing screw of the spectroscope. If the parts of the spectroscope all happen to be in exact adjustment, the true dark lines of the spectrum and these dust-lines will of course both be perfectly sharp for the same focal adjustment; but this is seldom the case for a fastidious eye.

This adjustment of focus having been accurately made, the telescope is then so directed that the edge of the sun's image shall cross the slit perpendicularly, and by sliding the whole spectroscope along its supporting bar a position is sought where the edge of the solar spectrum shall be perfectly defined as seen in the eyepiece of the spectroscope. When this has been accomplished the slit will evidently be exactly in the focal plane of those rays of the spectrum which occupy the field of view.

Of course if the object-glass is poor, or the air unsteady, no point of absolute sharpness can be found, and we have to be content with finding a minimum of indistinctness. But with good seeing and an object-glass well corrected for spherical aberration, the observation admits a really surprising degree of accuracy, successive determinations of the same point seldom differing, under such circumstances, as much as half a millimeter.

In this way the differences of focal length for different parts of the spectrum may be obtained with satisfactory precision: I say *differences* because the absolute focal length is all the time changing with the temperature, and that by a considerable amount; so that it is necessary to recur to and redetermine the zero point continually. This zero in my observations was the focal plane of the D lines.

In the table the first column contains the designation of the spectrum-lines observed, either by letters, or by their position on Kirchoff's map; the second gives the wave length according to Ångström. The remaining columns explain themselves, except that dF denotes the difference, expressed in thousandths of an inch, between the minimum focal length, and that for the particular ray of the spectrum in question, while the columns headed $\frac{d\mathrm{F}}{\mathrm{F}}$ contain the same quantity expressed in hundred thousandths of the focal length. I have added, for comparison, in the sixth column, the results of Lorenzoni for a Fraunhofer

object-glass of $1^m \cdot 750$ focal length; published in the Astronomische Nachrichten, vol. lxxviii, p. 289 (1871). His numbers were obtained by calculation and not by direct measurement, the computation being based upon Fraunhofer's determination of the indices of refraction for specimens of glass like that used in the lens.

Ray of Spectrum.		Gauss.		Littrow.	Fraunhofer.
Designation.	λ.	dF	$\frac{dF}{F}$	$\frac{dF}{F}$	$\frac{dF}{F}$
A	7600	0·199 in.	·00145	·00172	--
B	6866	·097	69	97	·00064?
C	6561	·052	37	49	52
D	5890	·002	1	0	2
1235 K	5590	·000	0	--	--
1474 K	5316	·004	3	35	--
E	5269	---	--	--	15
b	5183	·011	8	--	25
c	4956	·035	25	--	--
F	4860	·059	42	129?	72
2500 K	4530	·197	143	--	--
f	4471	---	---	--	214
2796 K	4340	---	---	294	271
G	4307	·370	262	--	289
h	4101	·626	437	444?	452
H	3968	·810 in.	·00575	·00650?	·00582

A glance at the table shows that as to the extreme rays there is very little difference between the three objectives, but that for the middle rays the Gauss lens is decidedly the best, and the Littrow the worst. The same thing is still better shown by the diagram of the color curves. The ordinates of these curves are taken from the columns $\left(\frac{dF}{F}\right)$ of the table: for abscissas I have used the values of $\frac{1}{\lambda}$ i. e., the number of wave-lengths to a millimeter. If we take the wave lengths themselves as abscissas, the left-hand portion of the curve is so flattened and extended, and the right-hand portion becomes so steep as to make the figure very inconvenient.

A ? is appended in the table to a few of the numbers which do not seem to fall in well with the general course of the curve to which they ought to conform.

Princeton, N. J., April 14, 1880.

Art. LX.—*Note on the Companion of Sirius;* by Asaph Hall.

In 1844, Bessel showed by a careful discussion of the observations of Sirius, that the right ascensions of this star could not be represented within the limits of their probable errors by means of a uniform proper motion. The residuals were distributed in a periodical form; and Bessel, after a simple and ingenious transformation of the equations of motion, and the assumption of a value for the annual parallax of Sirius, was led to infer the existence of a dark body near this star that disturbed its proper motion. This, indeed, seemed to be the only reasonable hypothesis left. It is evident, if we imagine such a system, that while the center of gravity of the two bodies would move in a right line, or apparently on the arc of a great circle, the stars themselves would be subject to periodical variations in their motions. Bessel's conclusion was criticised by W. Struve, in his studies on stellar astronomy, page 53 of the notes, who decided that Bessel was mistaken; but Struve's criticism does not seem to be well founded, and in 1851, Dr. C. A. F. Peters showed, in a very complete investigation of this question, that the observations of right ascension fully confirm Bessel's opinion. Peters also computed an orbit of the disturbing body, and found the time of its revolution to be fifty years. In 1861, Professor T. H. Safford found that the observations of declination indicate a similar disturbing force. In January, 1862, Mr. Alvan G. Clark discovered a companion of Sirius very nearly in the position pointed out by theory, thus confirming in a remarkable manner Bessel's hypothesis.

A very complete discussion of the observations of Sirius, both in right ascension and declination, and also of the micrometrical measurements of the Clark companion during the first five years after its discovery, was published by Professor Auwers in 1868. The identity of this companion with Bessel's disturbing body, is, in the opinion of Auwers, put beyond doubt by his investigation. The elements of the disturbing body found by him are nearly the same as those found before by Peters, and the accuracy with which the observations are represented by the elements is so great that confidence in the identity of the two bodies is fully justified. The weight to which this result is entitled is very great, especially since the variable proper motion of Sirius has been investigated by four able astronomers. Yet there are some things which seem to me to throw a slight degree of doubt on the identity of the Clark companion with Bessel's disturbing body: First, the relatively great mass of the companion, which, according to

Auwers, is one-half the mass of Sirius, or if we assume Gylden's parallax of Sirius, 0″·193, seven times the mass of our sun. Unless, therefore, we assume a special constitution for this companion, it ought to shine with the brilliancy of a star of the first magnitude, while in fact it is only of about the ninth magnitude. But the assumption of a peculiar constitution of the companion is purely arbitrary, and is not in itself plausible. Some observers, indeed, claim to have seen a disk to the Clark companion, but a real disk visible at the distance of Sirius would correspond to an enormous body, nearly filling the orbit of Venus; and, moreover, most observers have failed to see a disk.

Again, the micrometrical observations now extend over eighteen years, or more than one-third of the period of the disturbing body as determined by Peters and Auwers from the periodical variations in the right ascensions and declinations of Sirius, and these observations furnish some knowledge of the probable period of the Clark companion. The difference between the positions predicted by Auwers and the observed positions is not indeed very great, but the micrometrical observations indicate, I think, that the periodic time of the Clark companion will prove to be decidedly greater than what the disturbed motion of Sirius calls for. On this point we can not yet speak with confidence, but the doubt raised by the micrometrical measurements is sufficient, I think, to justify a suspension of judgment, and to incite astronomers to make careful observations of this interesting object. These measurements were begun in 1862 by Professor Geo. P. Bond, who found for that epoch

	p.	s.
1862.19	84°·61	10″·07

My own observations for the last seven years, together with the residual found by comparing with Auwers' predicted places, are given in the following table:

Date.	p.	s.	C − O.	
			Δp.	Δs.
1874.23	58°·05	11″·11	+7°·08	−0″·19
1875.28	56·38	11·08	+6·99	−0·34
1876.22	55·22	11·19	+6·47	−0·65
1877.26	53·38	10·95	+6·46	−0·68
1878.24	51·68	10·76	+6·24	−0·79
1879.20	50·13	10·57	+5·84	−0·91
1880.25	47·83	10·30	+5·81	−1·08

It is not worth while to speculate on these residuals, since we are now approaching a critical time, and a few more years of careful observation will go far towards deciding the question of identity.

April 9, 1880.

ART. LXI.—*Study of the Emmet County Meteorite, that fell near Estherville, Emmet County, Iowa, May* 10, 1879; by J. LAWRENCE SMITH, Louisville, Ky.

THE fall of this meteorite is in all its attendant circumstances one of the most remarkable on record. I therefore visited the region, on my return to America some months after its fall, and saw the two large masses which are the main representatives. Several short notices have already appeared on the subject; among them, one each, by Professor Shepard, Professor Peckham and Professor Hinrichs; and in describing the physical and chemical characteristics of the original masses, I shall be obliged to repeat some details that have been brought out.

Locality.—The place of fall is near Estherville, Emmet County, Iowa, just on the boundary of the State of Minnesota, lat. 43° 30′, lon. 94° 50′, within that region of the United States which has become remarkable for falls of meteorites, and of which I gave an outline map in my article on "the three meteorites that fell at Rochester in Indiana, Cynthiana in Kentucky, and Warrington in Missouri, within the space of one month."*

The State of Iowa has become particularly conspicuous in recent years as the landing place of these celestial messengers; and I now have under examination still another remarkable one with some peculiar physical characters, but about which I have not yet obtained the historic details.

The *phenomena accompanying the fall* were of the usual character, but on a grander scale. It occurred about five o'clock in the afternoon, under a clear sky, with the sun shining brightly. In some places the meteorite was plainly visible in its passage through the air, and looked like a ball of fire with a long train of vapor or cloud of fire behind it; and one observer saw it 100 miles from where it fell. Its course was from northwest to southeast. The sounds produced in its course are referred to as being "terrible" and "indescribable," as scaring cattle and terrifying the people over an area many miles in diameter. At first they were louder than that of the largest artillery; these were followed by a rumbling noise, as of a train of cars crossing a bridge. The concussion when it struck the ground was sensible to many persons, and it is reported that the soil was thrown into the air at the edge of a ravine where the largest of the masses was found. Two individuals were within two or three hundred yards of the spots where the two larger masses fell.

* This Journal, vol. xiv, 1877.

There were distinctly two explosions. The first took place at a considerable height in the atmosphere, and several large fragments were projected to different points over an area of four square miles, the largest mass going farthest to the east. Another explosion occurred just before reaching the ground, and this accounts for the small fragments found near the largest mass.

Impact with the earth.—A remarkable fact connected with the fall, besides that of the local disturbance of the earth alluded to, is the depth to which the mass penetrated. Had the fall taken place during the night, I doubt if the largest fragment would have been found. It struck within 200 feet of a dwelling house, at a spot where there was a hole (previously made) six feet deep and over twelve feet in diameter, filled with water, and having a bottom of stiff clay. This clay was excavated to a depth of eight feet before the meteorite was discovered, and two or three days elapsed before it was reached. Its total depth below the general surface of the ground was hence fourteen feet.

The second large mass was found embedded in blue clay about five feet below the surface, at a place two miles distant from the first. The third of the three largest masses was not discovered until the 23d of February, 1880, more than nine months after the fall, and its locality was four miles from the first. A trapper on the prairies, who had witnessed the original occurrence, observed a hole in a dried-up slough; on sounding it with his rat spear, he detected a hard body at the bottom, and on digging found the stone at a depth of five feet. Some small fragments were doubtless detached when the large mass approached the ground, as they were discovered near to it. The fragments thus far obtained weighed respectively, 437, 170, 92½, 28, 10½, 4 and 2 pounds.

Height and velocity.—A railroad engineer who observed it before the report, estimated its height to be forty miles, but at the time of the explosion much less; from an imperfect computation, he considered its velocity to be from two to four miles per second.

External characters. — The masses are rough and knotted like large mulberry calculi, with rounded protuberances projecting from the surface on every side; the black coating is not uniform, being most marked between the projections. These projections have sometimes a bright metallic surface, showing them to consist of nodules of iron; and they also contain large lumps of an olive-green mineral, having a distinct and easy cleavage, which is more distinct where the surface has been broken. The greater portion of the stony material is of a gray color, with this green mineral irregularly disseminated

through it. The two minerals are mixed under various forms; sometimes the green mineral is in small rounded particles intimately mingled with the gray, at other times it is in small cavities in minute crystalline fragments, without any distinct faces, and almost colorless. The masses are quite heavy and vary much in specific gravity in their different parts; but the average cannot be less than 4·5. When broken, one is immediately struck with the large *nodules* of metal among the gray and green stony substances, some of which will weigh 100 grams or more. In this respect this meteorite is unique, it differing entirely from the mixed meteorites of Pallas, Atacama, etc., or the known meteoric stones rich in iron; for in none of these has the iron this nodular character.

Another striking feature in the relation of the iron and stony matter is, that the larger nodules of iron appear to have shrunk away from the matrix; an elongated fissure of from one to three millimeters sometimes intervening, separating the matrix and nodules to the extent of one-half the circumference of the latter, and appearing as if the iron had contracted from the stony matrix during the process of cooling. There are numerous small cavities of various sizes, where there are not any iron nodules, and where the minerals appear more crystalline, indicating an irregular shrinkage during the consolidation.

The minerals.—At first sight I expected to find more than two earthy minerals. The microscope gave, as with most meteoric stones, unsatisfactory results. I therefore tried to separate the stony minerals mechanically; the only mineral that I was enabled to obtain pure in sufficient quantity, has an olive green color, and occurs in masses of from one-half to one inch in size, having an easy cleavage, especially in one direction; this is proved to be *olivine*. The same mineral occurs also in minute rounded concretions in other parts of the meteorite; and minute, almost colorless crystalline particles in the cavities I take to be olivine. *Nickeliferous* iron, as already stated, is very abundant. *Troilite* exists in small quantity. *Chromite* was also found.

That the stony part of this meteorite consists essentially of bronzite and olivine will be seen from the chemical investigation, which found only three essential constituents, viz: silica, ferrous oxides and magnesia. Another silicate will be referred to beyond, consisting of the same oxides, but in different proportions from either bronzite or olivine.

Chemical constitution.—The stony part, pulverized and freed as far as possible from metallic iron by the aid of the magnet, when treated with chlorhydric acid on a water bath for several hours, is resolved into soluble and insoluble parts, the propor-

tions varying very much with different fragments, and ranging from 16 to 60 per cent for the soluble part. This soluble part consists of silica, ferrous oxide and magnesia, and without a trace of lime, thus indicating the absence of anorthite.

(1) *Insoluble portion.*—The insoluble portion was carefully analyzed by fusion with carbonate of soda, and found to contain:

		Oxygen ratio.
Silica	54·12	29·12
Ferrous oxide	21·05	4·67
Chromic oxide	trace	
Magnesia	24·50	9·80
Soda with traces of potash and lithia	·09	·023
Alumina	·03	·013
	99·29	

The oxygen ratio clearly indicates the mineral to be $\dot{S}i\dot{R}$, being virtually $\dot{S}i(\dot{M}g\dot{F}e)$, or the common form of *bronzite* contained in meteorites.

(2) *Soluble portion.*—On testing the green mineral already referred to I found that this was the soluble portion, and it was readily detected in a pure state from the stony part of the meteorite. Its cleavage in one direction is very perfect; its specific gravity 3·35; hardness almost 7; pulverized, it is readily and completely decomposed by hydrochloric acid. Two analyses were made, one by decomposing it directly with hydrochloric acid over a water bath, and the other by first fusing it with carbonate of soda—the two analyses agreeing perfectly.

		Oxygen ratio.
Silica	41·50	22·13
Ferrous oxide	14·21	3·12
Magnesia	44·64	17·86
	100·35	

The above analysis gives the formula $\dot{S}i\dot{R}_2$, or that of olivine.

(3) *Opalescent silicate.*—In some parts of this meteorite, a silicate occurs, that is opalescent, of a light greenish-yellow color, and cleaves readily. In one instance I observed it making a notable projection on the surface. Although I had a number of fragments of the meteorite for examination, amounting to ten or twelve pounds, I did not obtain enough of the mineral to establish positively its true character, but I hope to obtain more. An analysis was made with about 100 milligrams of the pure mineral with the following result:

		Oxygen ratio.
Silica	49·60	26·12
Ferrous oxide	15·78	3·50
Magnesia	33·01	13·21
	98·39	

Equivalent to $\breve{S}i\breve{R}_2 + \breve{S}i_2\breve{R}$, one atom of bronzite plus one atom of olivine, a form of silicate that we might expect to find in meteorites.

(4) *The nickeliferous iron.*—As already stated this iron is abundant in the meteorite, and sometimes in large nodules of 50 to 100 grams; on a polished surface the Widmanstättian figures are beautifully developed by acid. On analysis it was found to contain:

Iron	92·001
Nickel	7·100
Cobalt	·690
Copper	minute quantity.
Phosphorus	·112
	99·903

(5) *Troilite.*—The proportion of troilite is not large, and it could be detached only in small fragments.

(6) *Chromite.*—When small pulverulent fragments of the meteorite are heated with hydrochloric acid for some time and the residual matter washed and dried, it is easy to find particles of the stony mineral more or less filled with minute black shining particles which are chromite.

The constitution of this meteorite, so far as I have been able to make it out, is therefore as follows:

Bronzite, abundant; *olivine*, abundant; *nickeliferous iron*, abundant; *troilite*, in moderate quantity; *chromite*, in minute quantity; *silicate*, not yet well determined.

It will be thus seen that in its composition the meteorite contains nothing that is peculiar. I should, however, give it a unique position among meteorites, on account of the phenomena accompanying its fall, especially the great depth to which it penetrated beneath the surface, and also because of its physical characters and the manner of association of its mineral constituents. I examined carefully for feldspar and schreibersite; but the absence of both lime and alumina (except as a trace) clearly proved the absence of anorthite; and the small particles of the mineral that might have been taken for schreibersite were found on examination in all instances to be troilite.

ART. LXII.—*The Oxidation of Hydrochloric Acid Solutions of Antimony in the Atmosphere;* by JOSIAH P. COOKE. (Contributions from the Chemical Laboratory of Harvard College.)

IN our original paper on the Atomic Weight of Antimony—Proceedings of the American Academy of Arts and Sciences, vol. xiii, page 21—we made the following incidental observation in explanation of certain precautions which we found to be necessary in order to secure the precipitation of pure antimonious sulphide:

"The precautions here described may seem unnecessary to those who are not familiar with the fact that a solution of antimony in hydrochloric acid oxidizes with very great rapidity in the air,—fully as rapidly as the solution of a ferrous salt. A solution reduced as we have described, which has at first no action on the iodized starch paste, will strike the blue color after it has been exposed to the air for only a few minutes. This property of an acid solution of antimonious chloride is mentioned by Dexter, in the paper already referred to, but we were wholly surprised by the energy of the action. By means of it, antimony can be dissolved in hydrochloric acid without the aid of nitric acid, or of any other oxidizing agent save the air, if only a certain amount of antimonious chloride has once been formed. When, after exposure to the air, the solution is boiled over pulverized antimony, the solution is reduced, and a further portion of the metal enters into solution. After a second exposure, the same process can be repeated, and so on indefinitely. The process is very slow and tedious, but, in one experiment, we succeeded in bringing into solution in this way several grams of antimony."

On the sole basis of this language we have been represented as asserting that such antimony solutions oxidize in the air as rapidly as a solution of *ferrous chloride*, and experiments on comparatively dilute solutions of antimonious oxide in hydrochloric acid have been adduced as proofs that our observation was incorrect.

As is evident from the context, the statement just quoted, although the result of a very extended experience, was not based on quantitative measurements. What we noticed was that the solutions *were very quickly acted on* by the oxygen of the atmosphere, and we freely admit that the expression here italicized is a more accurate description of our observation, than the words originally used as quoted above. But our meaning was not left in doubt, for we expressly say immediately after, that the process is very slow and tedious. In regard to the phenomenon in question, the effects are so obvi-

ous when once attention is called to them, that it is entirely unnecessary to confirm our previous observations except so far as to add the following quantitative determinations, which will serve to give an accurate idea of the extent of the action under the only conditions we have investigated, or in regard to which we have written.

In order to determine the amount of oxidation caused by the action of the atmosphere on a solution of antimony in hydrochloric acid, we reduced the oxidized solution by boiling the liquid over antimony bullets, and determined the loss in their weight. This method is fully described in our original paper, and is based not only on the reducing power of the metal, but also on the fact repeatedly observed, that after the reduction was complete, the smallest excess of the finely pulverized metal would not dissolve even after prolonged boiling, and in the presence of a large excess of acid, if only the solution was protected from oxidation.

We began our experiments by dissolving 1·0036 grams of pure antimony (a portion of the same used in our experiments on the synthesis of antimonious sulphide) in about 30 cubic centimeters of pure hydrochloric acid (sp. gr. = 1·175) adding 3 cubic centimeters of very dilute nitric acid (containing only about 5·4 per cent of HNO_3). After the solution was completed we added bullets made of pure antimony (the same that had been used in our previous experiments), and boiled the solution in an atmosphere of carbonic dioxide, using the same apparatus which we described in our previous paper (loc. cit.) After the reduction was ended, the solution was transferred to a flat-bottomed flask through a platinum tunnel, on which the bullets were retained, and after washing into the flask the last traces of the solution with as small an amount of hydrochloric acid as possible, the tunnel was removed, the bullets washed with water, and again weighed as at first on the platinum tunnel. In reducing the original solution 0·4100 of a gram of antimony were dissolved from the bullets. The solution now containing 1·4136 grams of antimony was next exposed to the air for different successive periods of time in a room having a varying temperature of from 15° to 30°, sometimes in the shade, and at other times on a window seat where the sun's direct rays fell on the flask during several hours of each clear day.

We give in the following table the weight of antimony dissolved from the bullets after each successive exposure to the air; the amounts in each case being determined with all the precautions described above and still more at length in our former paper:

Weight of Sb originally dissolved					**1·4136**
1.	Dissolved from balls after 3 days' exposure,				0·0150
2.	do. after 5 days'				0·0295
3.	do.	" 10	"	May 17 to May 27,	0·0600
4.	do.	" 23	"	May 27 to June 19,	0·1340
5.	do.	" 37	"	June 19 to July 26,	0·2960
6.	do.	" 120	"	July 26 to Dec. 24,	0·4481
					0·9826

During these experiments the volume of the solution was gradually increased by the hydrochloric acid used in washing as above described, so that at last the volume amounted to 100 cubic centimeters.

It will be noticed that the amount of oxidation increased with the time of exposure, and that so long as the amount was small it was as nearly proportional to the time as could be expected under the varying conditions. The increased activity shown by determination No. 5 appeared to be due to the intensely warm weather and bright sunshine during the period, and the last determination would seem to indicate that after the oxidation reached a certain limit the process went on more slowly as we should naturally expect, but, with the greatly varying conditions during this long period, no certain conclusion can be drawn in regard to the effect of any single cause.

The action we are discussing is entirely in harmony with the chemical relations of antimony. The most striking characteristic of this elementary substance is its tendency to form compounds of the radical antimonyl, SbO. The oxichlorides, the oxibromides and the oxi-iodides whose relations we have discussed so fully in our previous papers, are examples in point, and we have been continually surprised by the appearance of such compounds in reactions in the most unexpected ways. In this respect antimony closely resembles vanadium, and with this element antimony is more closely allied than with its familiar associate, arsenic. What the precise reaction is in the present case, we are not prepared to state. That it is not the simple conversion of a terchloride into a pentachloride we are convinced, and investigations are in progress which we hope will further elucidate the subject.

In this connection we may appropriately add that while the above determinations were in progress we repeated the experiment described on page 19 of our previous paper (loc. cit.). We treated in an open flask 5 grams of finely powdered pure metallic antimony with 50 cubic centimeters of strong and pure hydrochloric acid, to which we added only one cubic centimeter of the very dilute nitric acid (5·4 per cent) described above. The flask was placed in a warm protected place (30° C.) and shaken from time to time. Soon the acid became col-

ored reddish-yellow and the chemical action began. When it had apparently ceased, the contents of the flask were shaken together, and the solution became at once as colorless as water. But on standing in the air the color rapidly returned, spreading from the surface of the liquid downward. These phenomena were repeated again and again during four or five months, until the whole of the metal dissolved. According to the reaction usually assumed to take place under these circumstances, 5 grams of metal would have required 50 cubic centimeters of acid, so that the effect was obtained with only one-fiftieth of the amount required by this theory.

ART. LXIII.—*Note on a Relation between the Colors and Magnitudes of the Components of Binary Stars;* by EDWARD S. HOLDEN.

MUCH has been written on the colors of stars, but I do not know that a relation has been found between the magnitudes and the colors of binary stars such as is shown by the following tables.

In 1877 I noticed that, in a general way, the difference of the magnitudes of the two components A and B of a double star was less, the nearer A and B were of the same color to the eye. If this was not the result of chance but the consequence of some physical law, the relation should come out with greater distinctness when the stars chosen were certainly binary and not merely double. In this way, what would be lost by the exclusion of many pairs *probably* associated physically, would be more than compensated by the exclusion of all cases of mere accidental association—optically double stars. I therefore requested my friend, Mr. S. W. Burnham, to give me a list of all the stars which were certainly binary, which he has kindly drawn up. See Tables I and II.

Table I contains 122 stars certainly binary and with component stars of like color. The magnitudes and colors are from the best authorities. The mean difference of magnitudes (B–A) is $0^m{\cdot}53$.

Table II contains forty stars certainly binary, the components being of different colors; the mean difference of magnitudes (B–A) is $2^m{\cdot}44$.

These tables show then that *considering every known case of binary stars of known color:* I. *The components of the* 122 *binary stars of the same color differ in magnitude on the average only* $0^m{\cdot}5$.

II. *The components of the* 40 *binary stars of different colors differ in magnitude on the average* $2^m{\cdot}4$. What the physical explanation of this curious relation may be, we have not now

enough knowledge to say. The following extracts seem, however, to be worth recording in this connection:

"Since spectrum-analysis shows that certain of the laws of terrestrial physics prevail in the sun and stars, there can be little doubt that the immediate source of solar and stellar light must be solid or liquid matter maintained in an intensely incandescent state, the result of an exceedingly high temperature. . . . . The light from incandescent solid or liquid bodies affords an unbroken spectrum containing rays of light of every degree of refrangibility within the portion of the spectrum which is visible. As this condition of the light is connected with the state of solidity or liquidity and not with the *chemical* nature of the body, it is highly probable that the light when first emitted from the photosphere . . . . would be in all cases identical. The source of the differences of color, therefore, is to be sought in the difference of the constituents of the investing atmospheres."*

This conclusion, that the characteristic colors of stars are always due to the absorptive action of their atmospheres, is to be compared with the two following facts. First, the color of a solid body cooling and not surrounded with an absorptive atmosphere, would, as it cooled, pass through the shades *white*, *yellow*, *orange*, *red*, but not through *green*, *blue*, or *purple*. Second, we do not find *isolated* stars of decided green, blue or purple colors. A few such have been recorded, but in most cases erroneously.† In general such stars are small, and as far as I know invariably associated with larger stars. That is, the isolated stars appear always of the colors which would arise in the cooling of solid or liquid masses and never as if necessarily surrounded with absorptive atmospheres—*i. e.* never decided violet or purple.

In a binary star where A is brighter than B, Table II shows that the colors are usually different, and Struve has pointed out that in the vast majority of such cases the component B is blue or purple. Arago has suggested that the condition of the small star is an index of what the larger star will in process of time become, in the order of evolution. But any progress of evolution which obtains in binary stars, should, one would think, obtain also in isolated stars. We have just seen that there are no isolated purple stars. Whence it would appear that the conditions are strangely different in the two cases. The foregoing simply shows the incomplete nature of the data in the case before us. The statements in italics seem to me of interest and importance, and they are borne out by the following tables.

* Huggins and Miller, on the Spectra of some of the fixed stars: Phil. Trans. 1864, p. 429.

† For example, Admiral Smyth calls α Lyræ a "green" star.

TABLE I (by S. W. BURNHAM).

Binary Stars (with components of same color).

	Double Star.	Name.	A. mag.	B. mag.	B-A. mag.	Color.	Authority.	Remarks.
1	OΣ187		7·3	7·3	0·0	Blanches	De	
2	Σ1187		7·1	8·0	0·9	Albæ	Σ	
3	Σ1196	ζ Cancri	5·0	5·7	0·7	Flavæ	Σ	
4	Σ1216		7·5	8·2	0·7	Albæ	Σ	
5	Σ3121		7·5	7·8	0·3	Albasubflavæ	Σ	
6	Σ1338		7·0	7·2	0·2	Albæ	Σ	
7	Σ1348	Lyncis 157	7·5	7·6	0·1	Albæ	Σ	
8	Σ1356	Hydræ 116	6·2	7·0	0·8	Flavæ	Σ	
9	OΣ208	ω Leonis	5·0	5·5	0·5	[No colors in OΣ.]		
10	A. Clark	φ Ursæ Maj.	5·5	5·7	0·2	[No colors.]		
11	Σ1423	8 Sextantis	8·6	9·3	0·7	Subflavæ	Σ	
12	Σ1457		7·4	8·4	1·0	Albsfl	Σ	
13	OΣ224		7·3	8·0	0·7	[No colors noted.]		
14	Σ1476		7·2	8·0	0·8	Albæ	Σ	
15	Σ1500		7·6	8·2	0·6	Subflavæ	Σ	
16	Σ1517		7·3	7·3	0·0	Subflavæ	Σ	
17	OΣ234		7·0	7·4	0·4	[No colors in OΣ.]		
18	Σ1643		8·4	8·7	0·3	Albæ	Σ	
19	Σ1647	Virginis191	7·5	7·8	0·3	Albæ	Σ	
20	Σ1670	γ Virginis	3·0	3·0	0·0	Subflavæ	Σ	
21	Σ1728	42 Comæ	6·0	6·0	0·0	Flavæ	Σ	
22	OΣ261		6·3	6·7	0·4	Blanches	De	
23	Σ1734		7·2	7·9	0·7	Albæ	Σ	B called blue by Secchi.
24	Σ 266		7·5	8·0	0 5	Blanches	De	
25	Σ1757		7·8	8·9	1·1	Albæ	Σ	
26	Σ1781		7·8	8·2	0·4	Albasubflavæ	Σ	
27	Σ1785		7·2	7·5	0·3	Albæ	Σ	
28	Σ1788		6·7	7·9	1·2	Albæ	Σ	
29	Σ1808		8·0	9·0	1·0	Albæ	Σ	
30	OΣ298		7·5	7·5	0·0	Blanches	De	
31	Σ1820		8·2	8·5	0·3	Subflavæ	Σ	
32	Σ1863		7·1	7·4	0·3	Albasubflavæ	Σ	
33	Σ1865	ζ Bootis	3·5	3·9	0·4	Albæ	Σ	
34	Σ1876		8·1	8·6	0·5	Subflavæ	Σ	
35	Σ1883		7·0	7·0	0·0	Subflavæ	Σ	
36	OΣ288		6·3	7·2	0·9	Blanches	De	
37	Σ3091		7·7	7·7	0·0	Flavæ	Σ	
38	Σ1934		8·5	8·5	0·0	Albæ	Σ	
39	Σ1932	Coronæ 1	5·6	6·1	0·5	Eg. albæ	Σ	
40	Σ1937		5·2	5·7	0·5	Flavæ	Σ	
41	Σ1938	μ^2 Bootis	6·7	7·3	0·6	Albasubvir.	Σ	
42	Σ 2	Cephei 316	6·3	6·6	0·3	Flavæ	Σ	
43	Σ 13	Cephei 318	6·6	7·1	0·5	Subflavæ	Σ	
44	OΣ 12	λ Cassiopae	6·0	6·1	0·1	Blanches	De	Albasubfl.; albasubcacr, OΣ.
45	OΣ 20	66 Piscium	6·2	7·2	1·0	Blanches	De	
46	Σ 73	36Androm.	9·2	6·8	0·6	Aur.	Σ	
47	Σ 113	42 Ceti	6·2	7·2	1·0	Albæ	Σ	
48	H2036	Ceti 187	7·0	7·2	0·2	Blanches	De	
49	Σ 186		7·2	7·2	0·0	Albæ	Σ	
50	OΣ 38	γ Androm.	5.0	6·2	[1·2]	Cacr.	Σ	See note * below.

* Color of Σ given of BC as a single star. OΣ noted no difference in components. Some observers have called them yellow: blue.

TABLE I.—Continued.

	Double Star.	Name.	A. mag.	B. mag.	B-A. mag.	Color.	Authority.	Remarks.
51	Σ 228	Andro. 259	6·7	7·6	0·9	Albæ	Σ	
52	Σ 234		7·8	8·7	0·9	Albæ	Σ	
53	Σ 257		7·2	7·7	0·5	Albsubflavæ	Σ	
54	Σ 305		7·3	8·2	0·9	Flavæ	Σ	
55	Σ 333	ε Arietis	5·7	6·0	0·3	Albæ	Σ	
56	Σ 367		8·0	8·0	0·0	Albsubflavæ	Σ	
57	OΣ 52	P III. 1	6·2	6·7	0·5	Blanches	De	OΣ, Albæ.
58	Σ 412	7 Tauri	6·6	6·7	0·1	Subflavæ	Σ	
59	Σ 511		7·5	8·0	0·5	Albæ	Σ	
60	Σ 572	Aurigæ 4	6·5	6·5	0·0	Subflavæ	Σ	
61	Σ 577		7·7	7·7	0·0	Albæ	Σ	
62	Σ 589		8·0	8·0	0·0	Albsubflavæ	Σ	
63	Σ 619		8·7	8·7	0·0	Albæ	Σ	
64	OΣ 98	14 Orionis	5·3	6·8	1·5	Blanches	De	
65	Σ 676		7·5	8·5	1·0	Albæ	Σ	
66	Σ 677		7·7	8·0	0·3	Eg. albæ	Σ	
67	Σ 728	32 Orionis	5·2	6·7	1·5	Subflavæ	Σ	
68	Σ 749		7·1	7·2	0·1	Eg. albæ	Σ	
69	Σ 910	P VI. 105	8·3	9·0	0·7	Subflavæ	Σ	
70	Σ 932		8·2	8·3	0·1	Albæ	Σ	
71	Σ 948	15 Lyncis	5·2	6·1	0·9	Albvir	Σ	
72	OΣ156		6·5	6·6	0·1	Blanches	De	
73	Σ1037		7·1	7·1	0·0	Subflavæ	Σ	
74	OΣ170		7·1	7·3	0·2	Blanches?	De	Flavæ, OΣ.
75	Σ1074		7·8	8·2	0·4	White	Σ	
76	Σ1081		7·8	8·5	0·7	Eg. albæ	Σ	
77	Σ1093		8·2	8·2	0·0	Albæ	Σ	
78	Σ1104		6·7	8·3	1·6	Albæ	Σ	
79	Σ1110	Castor	2·7	3·7	1·0	Subvir	Σ	
80	Σ1126		7·2	7·5	0·3	Subflavæ	Σ	
81	Σ1944		7·5	8·1	0·6	Albæ	Σ	
82	OΣ296		7·0	8·6	1·6	[No colors in De.]	δOΣ	
83	OΣ298		7·0	7·4	0·4	Blanches	De	
84	Σ1989	π^2 Urs. Min.	7·1	8·1	1·0	Eg. albæ	Σ	
85	Σ1998	ξ Scorpii	4·9	5·2	0·3	Albsubflavæ	Σ	
86	Σ2021	49 Serpen.	6·7	6·9	0·2	Albæ	Σ	
87	Σ2026		8·6	9·1	0·5	Flavæ	Σ	
88	Σ2106		6·7	8·4	1·7	Albæ	Σ	
89	Σ2118	20 Draconis	6·4	6·9	0·5	Albæ	Σ	
90	Σ2114		6·2	7·4	1·2	Albæ	Σ	
91	Σ2130	μ Draconis	5·0	5·1	0·1	Albæ	Σ	
92	Σ2173	Ophiu. 221	5·8	6·1	0·3	Eg. flav. seu Aurea	Σ	
93	Σ2199		7·2	7·8	0·6	Subflavæ	Σ	
94	OΣ338		6·5	7·7	1·3	Jaunes	De	
95	Σ2262	τ Ophiuchi	5·0	5·7	0·7	Subflavæ	Σ	
96	Σ2267		8·0	8·0	0·0	Albæ	Σ	
97	Σ2281	73 Ophiuchi	5·7	7·2	1·5	Albæ	Σ	
98	Σ2315	Hercul. 452	7·0	8·0	1·0	Albæ	Σ	
99	Σ2384		8·0	8·5	0·5	Flavæ	Σ	
100	Σ2383	ε^2 Lyræ	4·9	5·2	0·3	Eg. albæ	Σ	
101	Σ2422		7·6	7·7	0·1	Albæ	Σ	
102	Σ2438		7·0	7·6	0·6	Albæ	Σ	
103	Σ2509		7·0	8·1	1·1	Subflavæ	Σ	
104	Σ2525	Cygni 22	7·4	7·6	0·2	Subflavæ	Σ	
105	Σ2556		7·3	7·8	0·5	Albæ	Σ	

TABLE I.—Concluded.

	Double Star.	Name.	A. mag.	B. mag.	B-A. mag.	Color.	Authority.	Remarks.
106	β 151	β Delphini	4·2	6·0	1·8	——— ———		*
107	Σ2729	4 Aquarii	5·9	7·2	1·3	Flavæ	Σ	
108	Σ2737	ε Equulei	5·7	6·2	0·5	Subflavæ	Σ	
109	Σ2744		6·3	7·0	0·7	Albæ	Σ	
110	Σ2758	61 Cygni	5·3	5·9	0·6	Flav. seu Aurea	Σ	
111	OΣ535	δ Equulei	4·5	5·0	0·5	Eq. flavæ	Σ	
112	Σ2799	Pegasi 20	6·6	6·6	0·0	Subflavæ	Σ	
113	Σ2804	Pegasi 29	7·3	8·0	0·7	Albæ	Σ	
114	Σ2847		7·6	8·0	0·4	Subflavæ	Σ	
115	Σ2909	ζ Aquarii	4·0	4·1	0·1	Albasubvir	Σ	
116	Σ2912	37 Pegasi	5·8	7·2	1·4	Albæ	Σ	
117	Σ2928		8·0	8·0	0·0	Albæ	Σ	
118	Σ3006		8·5	9·0	0·5	Albæ	Σ	
119	OΣ495		7·4	7·4	0·0	Blanches	De	
120	Σ3046		8·0	8·5	0·5	Albasubflavæ	Σ	
121	Σ3050	Androm. 37	6·0	6·0	0·0	Subflavæ	Σ	
122	Σ3056		7·4	7·4	0·0	Subflavæ	Σ	†
123	Σ3062		6·9	8·0	1·1	Flava	Σ	No. 50 omitted.

* Σ called the large star, single to him, green. Certainly binary. None of the observers note any difference in color.

† Binaries, same color: Σ (B–A) = $64^{m}\cdot2$; mean (B–A) = $0^{m}\cdot53$.

TABLE II (by S. W. Burnham).

Binary Stars (with components of different color).

	Double Star.	Name.	A. mag.	B. mag.	B-A. mag.	Color A.	Color B.	Authority.
1	Σ 60	η Cassiop.	2·0	7·6	5·6	Flava	Purpurea	Σ
2	Σ 208	10 Arietis	6·2	8·4	2·2	Flava	Cinerea	Σ
3	Σ 262	ι Cassiop.	4·2	7·1	2·9	Flava	Cærulea	Σ
4	Σ 295	84 Ceti	6·0	9·2	3·2	Flava	Cinerea	Σ
5	Σ 422	P III. 98	6·0	8·2	2·2	Aurea	Cærulea	Σ
6	Σ 460	Cephei 49	5·2	6·1	0·9	Flava	Subcærulea	Σ
7	Σ 535	Tauri 230	6·7	8·2	1·5	Subflava	Subcærulea	Σ
8	Σ 566	2 Camelop.	5·1	7·4	2·3	Flava	Subcærulea	Σ
9	β 86	β Leporis	3·5	10·0	6·5	Light gold	Light blue	De
10	Σ 742	Tauri 380	7·2	7·8	0·6	Subflava	Alba	Σ
11	Σ 963	14 Lyncis	5·9	7·1	1·2	Aurea	Purpurea	Σ
12	OΣ159	15 Lyncis	4·7	7·2	2·5	Jaune Clair	Azur Cendri	De
13	Σ 982	38 Gemino	5·4	7·7	2·3	Subflava	Subcærulea	Σ
14	Σ1066	δ Gemino	3·2	8·2	5·0	Subflava	Subpurpurea	Σ
15	Σ1273	ε Hydræ	3·8	7·8	4·0	Flava	Cærulea	Σ
16	Σ1356	ω Leonis	6·2	7·0	[0·8]	Flava	Cert. flava	Σ
17	Σ1374	Leo. Min. 30	7·0	8·3	1·3	Subflava	Eq. cærulea	Σ
18	OΣ215	P X. 23	6·5	7·3	[0·8]	Blanche	Blanc cendri	De
19	Σ1424	γ Leonis	2·0	3·5	1·5	Aurea	Rubrovir.	Σ
20	Σ1536	ι Leonis	3·9	7·1	3·2	Subflava	Cærulea	Σ
21	Σ1639	Comæ 68	6·7	7·9	1·2	Alba	Albasubcin.	Σ
22	Σ1768	25 Can. Ven.	5·7	7·6	1·9	Alba	Cærulea	Σ
23	Σ1877	ε Bootis	3·0	6·3	3·3	Eq. cærulea	Eq. cærulea	Σ
24	Σ1888	ξ Bootis	4·7	6·6	1·9	Flava	Rubropurpurea	Σ

TABLE II.—Concluded.

	Double Star.	Name.	A. mag.	B. mag.	B-A. mag.	Color A.	Color B.	Authority.
25	Σ1967	γ Coronæ	4·0	7·0	3·0	Albasubvir.	Purpurea	Σ
26	Σ2032	σ Coronæ	5·0	6·1	1·1	Subflava	Subcærulea	Σ
27	Σ2055	λ Ophiuchi	4·0	6·1	2·1	Flava	Subcærulea	Σ
28	Σ2084	ζ Herculis	3·0	6·5	3·5	Subflava	Subrubra	Σ
29	Σ2107	Hercul. 167	6·5	8·0	1·5	Subflava	Subcærulea	Σ
30	Σ2272	70 Ophiuchi	4·1	6·1	2·0	Flava	Purpurea	Σ
31	Σ2289	Hercul. 417	6·0	7·1	1·1	Flava	Subcærulea	Σ
32	Σ2382	ε' Lyræ	4·6	6·3	1·7	Albasubvir.	Albasubcærulea	Σ
33	Σ2579	δ Cygni	3·0	7·9	4·9	Subviridis	Cinerea	Σ
34	Σ2603	ε Draconis	4·0	7·6	3·6	Flava	Cærulea	Σ
35	OΣ413	λ Cygni	5·5	7·6	2·1	Blanche	Cendri Clair	De
36	A. G. Clark.	τ Cygni	4·9	7·4	2·5	Light yellow	Light blue	De
37	Σ2822	μ Cygni	4·0	5·0	1·0	Alba	Albasubcærulea	Σ
38	Σ2934		8·2	9·2	1·0	Albasubflava	Alba	Σ
39	OΣ483	52 Pegasi	6·0	8·0	2·0	Blanche	Cendri	De
40	OΣ489	π Cephei	4·4	7·5	3·1	Jaune Clair	Olivatre	De
41	Σ3001	o Cephei	5·2	7·8	2·6	Eq. flava	Eq. cærulea	Σ
42	OΣ507	B.A.C. 8277	6·3	7·7	1·4	Blanche	Cendri Olivatre	De

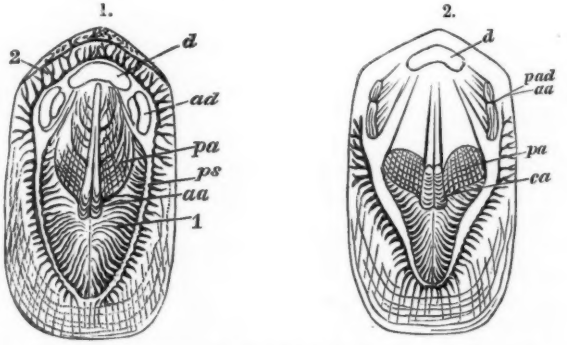
Binaries different colors: $\Sigma(B-A) = 97^m{\cdot}4$; mean $(B-A) = 2^m{\cdot}44$. (Nos. 16 and 18 omitted).

ART. LXIV.—*On the occurrence of true Lingula in the Trenton Limestones;* by R. P. WHITFIELD.

IT has been supposed by many that the Brachiopodous genus, *Lingula*, as represented by *Lingula anatina* Lamarck, a living species, was not represented among the fossil Lingulidæ of the older Paleozoic rock formations, if anywhere in rocks of Paleozoic age; and there has been a growing tendency to class all the Linguloid shells of these formations under other generic names. There is no question but that many of the forms represented in the Paleozoic rocks are really generically distinct from the living types; but I think we have proof in a species from the Trenton limestones of Wisconsin and Minnesota, that the true Lingulæ were represented by at least one species at that period. Several years ago I received from Dr. Aaron Elder, formerly of New York city, who had been spending a summer near Rochester, Minn., some internal casts of an undescribed Lingula. On examining them and finding the markings of the muscular scars and vascular lines very strong, I urged Dr. Elder to obtain more of the casts, at his next visit to that place, calling his attention particularly to these markings. During the following autumn I received other specimens, from some of which the accompanying figures and description of parts are taken. The species I propose to name *Lingula*

Elderi, after the discoverer, and a full description will be given, with figures, in the forthcoming Paleontological Report of the Geological Survey of Wisconsin.

The casts represent a species of moderate size, the average being about seven-eighths of an inch in length; the general outline is somewhat quadrate, the lateral margins being subparallel and a little convex, the upper end very obtusely angular or pointed, and the base rounded; the valves are convex, but the dorsal the most strongly so. The shell, when preserved, is smooth with very fine concentric lines, but presenting a polished appearance. The peculiar features are found in the preservation of the imprints left by the muscular and vascular scars on the shell, as copied on these internal casts, thus affording means of comparison with the corresponding organs of the living forms of the genus. These markings correspond more nearly to those of *L. anatina* Lam. than do those of any other



Silurian or Devonian species which I have ever examined, and although they do not exactly correspond still are as similar as one could expect in widely separated species. The variations consist in the position of the various muscular scars, and also somewhat in the lines of the pallial sinuses and in the ramifications of their branches. Nearly all the muscular areas have been identified on several individuals, and the anterior portion of the pallial sinuses with their interior ramifications, and the outer ones to a slight distance from the main trunks on most of them; while the ramifications of the posterior prolongations have been detected on two of the dorsal valves. I have not been able to trace all the elements of the muscular system, nor to detect the divisions between those forming the larger scars; some of which, in the recent forms, are seen to be composed of three or four elements; but where they are impressed so lightly on the shell and yet leave the trace of their advance over its

surface by the growth of the animal to interfere with their distinctness, this would scarcely be looked for in a fossil species.

On the cast of the dorsal valve (fig. 1) the impressions of the pallial sinuses (*p s*) are deeply marked and are widely separated, leaving the area within them very considerable; the central or inner ramifications (1) are very distinct, and the outer ones also for a short distance from the main branches; while the posterior branches (2) show the lateral ramifications only on the outer side. The divaricator muscular scar of the dorsal valve (*d*) is very large and curved forward at the sides, being situated well back near the apex of the valve. It has not been satisfactorily observed on the ventral side, as every specimen yet obtained has been more or less imperfect at this point, but it should be situated directly opposite that of the dorsal. The anterior adductor scars (*a a*) are small and situated near the center of the valve, while the posterior adductors (*p a*) are large and situated outside of, and posterior to them; so as to inclose their posterior ends. The scars of the adjustor muscles are distant from each other, and placed just within the posterior third of the length of the shell. Two elements can be detected in each scar on some individuals, but they are usually obscure.

In the ventral valve (fig. 2) the lines of the pallial sinuses are nearer together on the anterior half of the cast than on the other valve, which feature is remarkably similar to these lines as shown in *L. anatina*, but spread out rapidly toward the middle and on the posterior half occupy nearly the same relative position as on the dorsal side. Near the center of the valve are seen a pair of large scars which have progressed from behind, their track forming a strong feature on the cast, as it originates just in front of the divaricator muscle scar (*d*) and gradually widens as it advances until it occupies fully one-half the width of the cast near the middle of its length. In the central line of this track there is an elevated ridge which terminates in a slightly prolonged tongue and seems to represent the central adjustors (*c a*) and their track of advance. The large scars outside of these are probably the posterior adductors and external adjustors combined (*p a*), each scar being formed of two elements. Posterior to these and distant from the median line are other scars which are long and narrow, their length being parallel to the margin of the valve. These also have left their track of advance, having started from a point just in advance of the anterior margin of the divaricator muscle. Two elements are recognized on each side and represent the posterior adjustors and probably the anterior adductors combined (*p a* and *a a*.) Between the lines formed by the advance of the adjustor muscles and those occupying the central area, on each

valve are narrow, smooth, impressed spaces which unite with the lines of the pallial sinuses at the junction of the anterior and posterior branches, and extend to the position of the divaricator muscle scar. They are seen on all the specimens but I have not been able to identify them with any organs, and it is probable they are only the spaces of unoccupied shell between the scars of the adjacent muscles and their tracks of advance, as they are within the area of the muscles and consequently within the perivisceral chamber. The area of attachment of the posterior muscular walls of the perivisceral chamber have not been detected, unless they have occupied a portion of the area assigned to the posterior branches of the pallial sinuses as seen on the dorsal valve. In which case there could have been only external ramifications from this portion of those organs, instead of both external and internal, as in *L. anatina.*

In making these comparisons and in identifying the several muscles and other organs as represented on the casts, I have made use of the very excellent memoir "On the organization of the Brachiopoda," by Albany Hancock, Esq., published in the Trans. Phil. Soc. of England in 1858, a comparison with which cannot fail to convince any one of their intimate generic relations with *L. anatina.*

ART. LXV. — *Notes of Experiments upon Mr. Edison's Dynamometer, Dynamo-machine and Lamp;* by Professors C. F. BRACKETT and C. A. YOUNG, of Princeton, N. J.

DURING the experiments of Professors Rowland and Barker, the results of which appeared in the April number of this Journal, one of us (Professor Brackett) happened to be present; and he was requested by Mr. Edison to make an independent study of the subject under investigation.

Accordingly, we visited Menlo Park on March 19th and again on April 3d. On our first visit, we confined ourselves mainly to a study of the resistance, luminosity and efficiency of the lamp, making only a single test of the efficiency of the machine. On the second visit, we gave our attention to the dynamometer and the machine.

It is obvious that the work attempted in the time at our disposal was considerable; and, in consequence, no extreme accuracy is claimed for our results—though we believe them to be substantially correct—that is to say, within one or two per cent.

We first made a comparison of Mr. Edison's dynamometer with the well known Prony, the latter being driven through the former precisely as the dynamo-machine was, during the

trials made to determine its efficiency. We found that the Prony registered 93·2 per cent of the power transmitted by the Edison. This result we consider quite reliable, the 6·8 loss being reasonably accounted for by friction of counter-shaft journals and the slip of the belt intervening between the instruments.

To determine the efficiency of the dynamo-machine, we made three different tests. In all of them the power expended in driving the revolving armature was measured directly by the Edison dynamometer. The small additional amount spent in maintaining the field of force was calculated from the measured resistance of the magnet coils (1·47 ohms) and the difference of electric potential between the terminals of the coils, measured by a high resistance galvanometer (Thomson). It was assumed in this calculation that the machine which furnishes this current was of about the same efficiency as the one experimented on, it being of similar construction. The formula is

$$1{\cdot}25 \times 44{\cdot}25 \text{ ft. lbs.} \times \frac{V^2}{r} \times t,$$

where t is the duration of the experiment in minutes. V is the difference of potential in volts; r is the resistance or the coil 1·47 ohms. 44·25 is the number of foot lbs. of work done in one minute by an electromotive force of one volt driving a current through one ohm; and finally 1·25 is a factor embodying the assumption that the efficiency of the machine, producing the magnetizing current, is 80 per cent. The amount of this expenditure is trifling, not exceeding three per cent of the work used in driving the armature but its neglect might lead to misapprehension.

On March 19th the current produced was measured by the electrolytic method. We employed copper electrodes presenting opposed surfaces of about one square foot each, and placed about one inch apart in a solution of cupric sulphate. We also measured the resistance of the circuit by the bridge method both at the beginning and end of the experiment so as to take account of heating. For a check, we also measured the difference of potential between the terminals of the machine.

On April 3d we had recourse to the calorimeter, employing a resistance coil immersed in about 175 lbs. of water, the resistance of the coil being such that the work done elsewhere in the circuit could be calculated and allowed for as a small fraction of that directly measured. The difference of potential between the terminals was also measured for a check, as on March 19th. The resistance of the armature was 0·14 of an ohm; that of the rest of the circuit was made to vary in the different experiments, from 1·9 to 3·2 ohms.

We shall use the expression *available energy* to denote the energy developed in that part of the circuit which is outside of

the machine. The total energy of course includes that which is uselessly spent in heating the coils of the armature itself, a very small portion in this form of machine. Our results are as follows.

On March 19th the experiment lasted five minutes. We found:

Energy expended in driving armature	971,500 ft. lbs.
Energy expended on field of force	16,400 "
Total	987,900 "

The current calculated from the amount of copper deposited was 34·335 webers: the mean resistance of the circuit was 3·12 ohms, or, excluding the armature, 2·98 ohms. The electromotive force, indicated by the galvanometer, was 102·36 volts.

From these data we calculate:

Total energy realized in the current	814,400 ft. lbs.
Available energy (excluding armature)	777,200 "

Hence the total efficiency is 82·3 per cent, and the available efficiency 78·7 per cent.

On April 3rd the first test lasted $13^m\ 50^s$, and we found—

Energy expended in driving armature	2,844,600 ft. lbs.
Energy expended on field	19,634 "
Total	2,864,234 "

The total weight of calorimeter and its contents was 197·5 lbs. Making the proper reduction for weight, metals, thermometer, etc., we find the heat capacity of the whole to be 172·77 water lbs.

The rise in temperature, measured by a thermometer, easily read to $\frac{1}{20}$ of a degree, was 16·7° F.; and the precaution was taken to terminate the experiment when the temperature had risen as much above that of the air (71·2°) as it was below at the beginning, thus obviating the necessity of a radiation correction.

The resistance of the coil in the calorimeter was 1·72 ohms; that of the leading wires was only about 0·006, or $\frac{1}{300}$ of the preceding. Hence assuming 772 ft. lbs. as the mechanical equivalent of heat we have—

Energy developed in calorimeter	2,227,500 ft. lbs.
Energy developed in leading wires	7,425 "
Energy developed in armature	183,670 "

That is to say:

Total energy realized	2,418,600 "
Available energy realized	2,234,925 "

which makes the total efficiency 84·6 per cent and the available efficiency 78·2 per cent.

During the experiment the electromotive force of the current by which the field magnets were maintained was only 6·25 volts, consequently the machine was not giving nearly its maximum current—the energy expended being about 6·25 horse-power and the current about 46 webers.

During the next test, which continued nine minutes, the electromotive force of the field coils was maintained at 14·9 volts, and the current produced was 57·5 webers—consuming 9·5 horse power.

The calorimeter was refilled with fresh water; and proceeding as before we found—

Energy measured by dynamometer	2,827,550	ft. lbs.
Energy expended on field	72,180	"
Total	2,899,730	"
Energy realized in calorimeter	2,259,700	ft. lbs.
Energy realized in leading wires	7,532	"
Energy realized in armature	183,930	"
Total	2,451,162	"
Available	2,267,238	"
Total efficiency	84·5	per cent.
Available efficiency	78·2	"

These results were confirmed by the reading of the high resistance galvanometer.

Tabulating our results they stand thus:

	Total efficiency.	Available efficiency.
1st	82·3 per ct.	78·7 per ct.
2d	84·6 "	78·2 "
3d	84·6 "	78·2 "
Mean	83·8 "	78·4 "

If we assume that the indications of the Prony dynamometer are reliable and that the loss in transmitting power between the Edison dynamometer and the arbor of the armature was only the same as the loss between the two dynamometers, the above numbers will have to be increased in the ratio of 100 to 93·2, and we shall have—

Total efficiency	89·9 per cent.
Available efficiency	84·1 "

These figures we believe fairly represent the performance of the machine in its present condition.

As points of excellence in the construction of this machine, we may mention the employment of large masses of iron for the field magnets; the breaking up of the armature core into thin plates, thus avoiding the expenditure of much useless

work; and finally, the almost entire absence of sparks at the commutator brushes, even when the machine is doing its maximum of duty.

Test of the Lamp.

The photometric tests were made by the well known method of Bunsen. The lamp, which was furnished us, was No. 853, one of the old pattern with carbon of charred paper, which had been used by Professors Rowland and Barker.

An arrangement was adopted by which the current employed, the difference of potential of the lamp wires and the resistance of the lamp could be measured, continuously, during the photometric observations. The current was measured by the deposition of copper in an electrolytic cell. The resistance was found by making the lamp one arm of a Wheatstone's bridge, suitably proportioned. The difference of potential was measured by a Thomson's high resistance galvanometer connected with the lamp terminals.

During the first test, which lasted twenty minutes, the mean photometric intensity "broad-side on" was 13·8 candles. Calculation shows the mean illumination to be about 73 per cent of the maximum, hence, the mean illumination was about 10·1 candles.

The resistance of the lamp, while shining, was found to be 99·6 ohms; and the difference of potentials at its terminals was 74·33 volts. (producing a current of 0·75 weber); hence the lamp was consuming 0·075 of a horse power. Or, adopting our previous result for the available efficiency of the dynamo-machine, we find that one horse-power *measured at the Edison dynamometer* would maintain a number of lamps represented by the formula $\frac{78{\cdot}4}{0{\cdot}075 \times 100} = 10{\cdot}5$, nearly.

During the second test, which lasted thirty minutes, the mean candle power of the lamp was 10·7 candles, calculated as before.

The resistance was	99·7 ohms.
The difference of potential	76·5 volts.
The current	0·76 weber.

Accordingly the lamp was consuming 0·077 of a horse-power —or one horse-power applied as before, would maintain 10·2 lamps at this candle power.

Taking the mean of these results we find that one horse-power *applied at the dynamometer* would produce in a lamp of this pattern and dimensions a light of 107 candles; or about 137 candles if we estimate the energy actually developed in the lamp in terms of horse-power.

Mr. Edison kindly put everything we required at our disposal, and himself, as well as Mr. Upton and his other assistants, aided us in every possible way.

ART. LXVI.—*On Substances possessing the Power of Developing the Latent Photographic Image;* by M. CAREY LEA, Philadelphia.

ABOUT three years since, I communicated to this Journal the results of a long series of studies on development. At the time when these were undertaken there were but four substances known to possess the power of development: ferrous sulphate, gallic acid, and pyrogallol, which had been long known to have this property, and hæmatoxyline, which I had some years before added to the number.

The studies made three years ago prove that the power of development, so far from being possessed by this small number of substances only, extends to a large number of chemical compounds, and is exhibited by many cuprous salts, by several vegetable acids, glucosides, etc. But the most curious result obtained was with ferrous salts. It was known that ferrous sulphate, though a powerful developer in the so-called "wet development," i. e., development in presence of a soluble silver salt, had no power whatever for those developments in which no soluble silver salt was present, and where the development was to be made at the expense of the film itself. I was able to show that ferrous oxide combined with almost any organic acid, possessed this power of forming a visible image at the expense of the film. So that a solution of ferrous sulphate by mixing with one of an alkaline oxalate, succinate, salicylate, etc., immediately acquires the power of development. Ferrous oxalate exhibits the power of development to a degree so remarkable that it seems likely to displace the older methods.

The study of the subject was resumed during the past winter, and with the result of ascertaining that this power of developing was not limited to the organic salts of ferrous oxide, but was possessed by many of its inorganic compounds. It certainly has never been suspected that such compounds as *ferrous phosphate*, *ferrous borate*, *ferrous sulphite*, *ferrous hypophosphite*, etc., possessed the power of development, but this they undoubtedly do, and not in any uncertain way. On the contrary, some of these compounds are among the most powerful of all known developing agents, equalling, or possibly even exceeding, ferrous oxalate in this respect, so that it is far from impossible that some of them may pass into technical use in preference to those now employed.

Some of these ferrous salts, especially the phosphate, sulphite and borate, are, like the oxalate, insoluble in water, and therefore need to be got into solution. As these salts are not, like the oxalate, soluble in the corresponding alkaline salt, at

least not to any useful extent, it becomes necessary to find an appropriate solvent. The most available solvents are solutions of ammonium and potassium oxalate, and of ammonium and sodium tartrate. Of these, the first have the material advantage that the ferrous salts remain permanently in solution, whereas with ammonium and sodium tartrate they are apt gradually to be precipitated.

As ferrous oxalate is a powerful developer, the question immediately presented itself whether the developing power exhibited, for instance by ferrous phosphate dissolved in ammonium oxalate might not be due to the formation of ferrous oxalate. But several reactions contradict this supposition. When a hot solution of ammonium (neutral) oxalate is fully saturated with ferrous phosphate, a precipitate separates in cooling, and this precipitate is not ferrous oxalate but ferrous phosphate. Again, ferrous phosphate exhibits powerful developing properties when dissolved in sodic or ammonic tartrate. This reaction is, however, not in itself decisive, inasmuch as I find that ferrous tartrate has itself developing properties. But as ferrous phosphate is to some extent soluble in a solution of ferrous sulphate, and as ferrous sulphate (in the form of development here under consideration, namely: in the absence of soluble silver salt) is wholly without developing power, an opportunity offered itself of testing the question. And it proved that a solution obtained by adding one of disodic phosphate to one of ferrous sulphate until a permanent precipitate began to form, undoubtedly possessed developing powers, though in a less degree.

The number of ferrous salts capable of developing the latent image is very considerable. Singular anomalies are often shown; a given salt prepared in one way may develop, while prepared in another it may have no such power. Nor is it possible to form an opinion beforehand as to whether a given compound of ferrous oxide will exhibit this power or not; compounds nearly allied do not exhibit analogies in this respect. For example: ferrous phosphate and ferrous metaphosphate are active developers, while ferrous pyrophosphate has no similar power.

Among other ferrous salts possessing more or less developing power, may be mentioned ferrous hyposulphite (hydrosulphate), ammonio-chloride, acetate, antimonio-tartrate, etc. Ferrous formiate, which might naturally be expected to be a powerful developer, is almost, though not entirely, destitute of the property. The most active agents found were ferrous borate, phosphate, sulphite and oxalate, respectively dissolved, the phosphate in neutral ammonium oxalate, the others in neutral potassium oxalate.

May, 1880.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Volumetric determination of Active Oxygen in the Peroxides of Barium and of Hydrogen.*—Owing to the increasing commercial use of barium dioxide, and the consequent necessity of knowing its value, Bertrand has elaborated a process for estimating volumetrically the active oxygen which it contains. This process is founded on these two reactions: $BaO_2+(HCl)_2=H_2O_2+BaCl_2$ and $H_2O_2+(KI)_2=K_2O+H_2O+I_2$. Hence one gram of iodine corresponds to 43·8355 c.c. of active oxygen. The free iodine is titered with a solution of sodium hyposulphite, though starch is not used as an indicator. The potassium iodide solution contains 200 grams to the liter, the hyposulphite is a tenth-normal solution. Exactly half a gram of the dioxide is dissolved in one or two cubic centimeters of pure hydrochloric acid diluted with 100 to 150 c.c. of water. To the solution is added 10 c.c. of the iodide solution, when free iodine at once appears. After about ten minutes, the acid is saturated with pure hydro-sodium carbonate, and the titred solution of hyposulphite is allowed to run into it from a burette until the solution is perfectly colorless. From the volume of hyposulphite used, the amount of active oxygen in the sample is easily calculated. By multiplying the number representing the oxygen in a gram of the dioxide by 1·5287, the percentage of BaO_2 is obtained. For commercial use, the author has suggested a special form of apparatus which he calls an oxybarymeter. It is a Mohr burette of 50 c.c. divided into half centimeters, and specially graduated, the first cubic centimeter being marked 41 per cent and the last 90 per cent. Using in it a solution of 14·569 grams hyposulphite to the liter, each cubic centimeter represents one per cent of BaO_2. Since the commercial samples never contain less than 40 per cent, 40 c.c. of the hyposulphite solution is added at once from a pipette and the titrition is completed from the oxybarymeter, from which is read directly the percentage of BaO_2 in the specimen. Three French samples gave 62·83, 66·42, 74·78 per ct. BaO_2 respectively. Two German ones gave 67·93 and 82·40 per ct. Two others 68·24 and 58·62 per ct. Hydrogen dioxide is treated similarly, a known volume being mixed with dilute hydrochloric acid and titered as above. An apparatus for effecting this analysis commercially, has also been devised by the author. He calls it a hydroxymeter.—*Bull. Soc. Ch.*, II, xxxiii, 148, Feb., 1880. G. F. B.

2. *On the action of Dry Sulphurous Oxide upon the Alkali-earths.*—The behavior of calcium oxide toward carbon dioxide at moderately high temperatures, has led Birnbaum and Wittich to study the action of sulphurous oxide upon all of the alkali earths. The gas was evolved by gently heating a saturated aqueous solution, and was thoroughly dried by passing it through sulphuric acid and through tubes filled with glass fragments

moistened with the same acid. It then passed into small flasks through lateral tubulures, the necks being closed at top, and thence through a final drying apparatus into the flue. The flasks contained weighed quantities of the earths, and were heated to definite temperatures in a water bath, a paraffin bath, a bath of melted tin (230° C.), of an alloy of tin and lead (290° C.), of pure lead (326·2° C.) and of zinc (415·3° C.). The heating in the gas current was continued until the weight became constant, the experiment being interrupted from time to time, the apparatus allowed to cool, the dioxide displaced by dry air and the flask weighed. After the experiments, the contents of the flasks were analyzed. The results were as follows: Barium oxide though beginning to absorb sulphurous oxide at 200° C., absorbed it more rapidly in the tin bath, becoming completely saturated in about four weeks. The resulting product was completely soluble in hydrochloric acid, contained no sulphate or sulphide and afforded 29·36 per cent SO_2, the formula $BaSO_3$ requiring 29·49. Strontium oxide was less active, the first evidences of absorption appearing at 230° C., and increasing at 290°, a constant weight being obtained after six weeks. The product was neutral strontium sulphite, containing 38·18 per cent SO_2. Calcium oxide does not absorb sulphurous oxide gas below 400°, but when the flask was placed in the bath of melted zinc, rapid absorption took place, the weight being constant in two or three days, and the product being a pure calcium sulphite. It was not, however, a normal sulphite but contained 48·78 per cent SO_2 and gave the formula $Ca_2S_2O_{16}$. At higher temperatures, more gas was absorbed, but the product split into sulphate and sulphide. Magnesium oxide absorbed the gas at the temperature of melted lead, but the operation was so slow that three months passed before the weight became constant. Then the product consisted entirely of neutral sulphate, the temperature of absorption lying very near the temperature of decomposition of the sulphite.—*Ber. Berl. Chem. Ges.*, xiii, 651, April, 1880. G. F. B.

3. *On the Constitution of Selenous Acid.*—The constitution of sulphurous acid has been regarded as represented by the formula $H.SO_2OH$, chiefly on the ground given by Strecker, that its salts formed sulpho-acids when treated with iodides of the alcohol radicals. For the purpose of ascertaining whether selenous acid was similarly constituted, MICHAELIS and LANDMANN have tested it in the same way, potassium selenite being heated with ethyl iodide. At moderate low temperatures no reaction takes place; but when more strongly heated, free selenium, potassium iodide and alcohol result. Benzyl chloride, heated in the same way with potassium selenite gives selenium, potassium chloride, bitter almond oil and some benzoic acid. To test the question further, advantage was taken of the fact that sulphurous acid forms two isomeric ethers $SO\begin{cases} OC_2H_5 \\ OC_2H_5 \end{cases}$ and $C_2H_5.SO_2OC_2H_5$, the former by the action of thionyl chloride on sodium alcoholate, the latter by

the action of ethyl iodide on silver sulphite. The corresponding selenium compounds, treated in this way, afforded completely identical ethers both having the constitution $SeO\left\{\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}\right.$, and both affording selenous acid on decomposition with water. Selenous acid then is a true dihydroxyl acid $SeO\left\{\begin{matrix}OH\\OH\end{matrix}\right.$, and different from sulphurous acid.—*Ber. Berl. Chem. Ges.*, xiii, 656, April, 1880.

G. F. B.

4. *On the Occurrence of Vanillin in Raw Beet Sugar.*—Certain samples of crude sugar prepared from the beet root, and especially those made by the maceration process, have been observed to possess a strong vanilla odor. SCHEIBLER has examined such sugars and finds that they contain a substance apparently identical with vanillin. To obtain it the sugar was extracted with ether in a percolator, the ether being repeatedly distilled through the mass. The ether extract, about 3·8 grams, was redissolved in ether, and the solution was allowed to evaporate spontaneously in a tall beaker. After some days, large, beautiful and nearly pure crystals formed at the bottom, while cauliflower-like efflorescences formed on the side of the vessel. After recrystallization, the crystals gave a strong vanilla odor, fused at 79° (uncorrected), sublimed to an oily liquid which solidified in radiating needles and behaved precisely like a sample of vanillin from Haarmann and Reimer's laboratory. The quantity was too small for an elementary analysis.

VON LIPPMANN, simultaneously but independently, has also isolated vanillin from raw beet sugar. Two kilograms of the sugar were dissolved in the minimum of water, the solution exactly neutralized with hydrochloric acid, and agitated with pure ether. After standing the ether was withdrawn by a separating funnel. By 170 of these extractions a sufficient quantity of material was obtained to examine. The residue was dissolved in as little ether as possible, and agitated with concentrated hydro-sodium sulphite solution. The solution thus obtained was treated with dilute sulphuric acid, the sulphurous oxide driven off by heat and the cooled liquid again extracted with ether. Oily drops were left on evaporation, but soon solidified. After purification, the substance was obtained as small pure white star-shaped groups of needles, possessing the odor and taste of vanilla. It was easily soluble in ether, alcohol, chloroform, and petroleum naphtha, difficultly in benzene and hot water, fused at 80°, and by careful heating sublimed undecomposed. Its solution reacted acid, reddened litmus, decomposed carbonates and reduced ammonical silver solutions on warming. Elementary analysis gave C 63·28 and H 5·58, the formula $C_8H_8O_3$ requiring 63·16 C and 5·26 H. Its identity with vanillin is therefore established.—*Ber. Berl. Chem. Ges.*, xiii, 335, 662, March, April, 1880.

G. F. B.

5. *On the Conversion of Hyoscyamine into Atropine.*—It is a well-known fact that hyoscyamine splits up into hyoscinic acid

and hyoscine on boiling with hydrochloric acid; and also that atropine, thus treated, breaks up into tropic acid and tropine. Some time ago, LADENBURG called attention to the very close similarity between hyoscinic and tropic acids. He now shows that there is the same relation between hyoscine and tropine, these two bodies being identical. Their platinum chlorides have the same crystalline form, the free bases have the same boiling point, 229°, the same fusing point 62°, and they afford the same numbers on analysis. The curious fact now appeared that two isomeric alkaloids gave identical decomposition products. To test the matter synthetically three experiments were made: (1) Tropine from atropine and hyoscinic acid from daturine were treated with hydrochloric acid on the water bath; (2) Hyoscine from hyoscyamine and tropic acid from atropine were thus treated; and (3) Hyoscine from hyoscyamine and hyoscinic acid from hyoscyamine, were also treated in the same way. The residue, after neutralization and extraction with alcohol, was dissolved in hydrochloric acid, and precipitated with gold chloride. In each case atropine-gold chloride was the product; thus proving the identity of their decomposition products and establishing the conversion of hyoscyamine into atropine.—*Ber. Berl. Chem. Ges.*, xiii, 607, April, 1880. G. F. B.

6. *On the Product of the Oxidation of Albumin by Permanganate.*—The question whether by the direct oxidation of albumin, urea is produced, has been an open one. LOSSEN has now repeated with care the experiments of Béchamp and others, 500 grams of purified egg-albumin being diffused in 400 c.c. of water containing 30 grams potassium hydrate, the equivalent quantity of magnesium sulphate being added, and then 375 grams $K_2Mn_2O_7$ and 294 grams of the sulphate put in gradually. From the liquid a crystalline substance was obtained which at first was supposed to be urea, but which proved to be guanidine. No urea whatever could be detected.—*Liebig's Annalen*, cci, 369, Feb., 1880. G. F. B.

7. *On Maxwell's Theory of Light.*—The author, J. G. THOMSON, reviews the results which are contained in Prof. Maxwell's treatise on Electricity and Magnetism, and adds a discussion of his own upon the interpretation of the equations given by Maxwell when they are modified to embrace the new condition of a motion of the medium through which the light passes. Suppose that the dielectric moves with a velocity u in the direction of the propagation of the light. Let V be the velocity of propagation of light in the dielectric when it is at rest; the author finds $\frac{q}{p} = \frac{u}{z} + V$ approximately. In which $\frac{q}{p}$ is the velocity of propagation of light in the medium. The conclusion is, therefore, drawn that the velocity of the light is increased by one-half the velocity of the dielectric.—*Phil. Mag.*, April, 1880, p. 284. J. T.

8. *Suggestions in regard to Crystallization.*—Mr. S. TOLVER PRESTON discusses crystallization under the following assumptions:

1. Molecules are elastic. 2. Molecules possess an open structure. 3. The ether is a gas whose atoms are so small that their mean length of path is greater than any planetary distance. The motion of these atoms produces the phenomena of gravitation on Le Sage's principle.

Various crystalline forms are regarded as due to the yielding of the ultimate particles of matter under different conditions of stress and strain; and the conception of elastic molecules is contrasted with that of infinitely hard molecules.—*Phil. Mag.*, April, 1880, p. 267. J. T.

9. *Solubility of Gases in Solids.*—Messrs. HANNAY and HOGARTH have experimented upon this subject with the following modifications of Andrews' apparatus: "a T-tube of wrought iron, one-half inch internal and one inch external diameter, was furnished with wrought iron screw cups. Through one of these the pressure screw works; through the opposite end the experimental tube is fixed. The side branch, about three inches long admitted an air manometer. The apparatus, which was less than twelve inches in length, was filled with mercury." The packing consisted of India rubber plugs covered with greased leather, through which the pressure screw passed. At high pressure the tube was cemented with oxychloride of zinc. This simple method of packing gave freedom of motion at the pressure, even, of 880 atmospheres. With this apparatus various crystals dissolved in alcohol gas, and the authors obtained solutions of sulphur, selenium, and arsenic in bisulphide of carbon, in a more or less conclusive manner. The authors conclude that the critical point of a gas is altered by having a solid dissolved in it, and claim that, since their experiments were made at temperatures much more remote from the critical point than those of Andrews, they have given still further evidence of the continuity of the liquid and gaseous states.—*Nature*, March 25, 1880. J. T.

10. *Chemical Affinity in terms of Electromotive Force.*—Dr. WRIGHT reviews the work of Joule and others upon the Mechanical Equivalent of the operation of Electrolysis, and is led to a discussion of the various results obtained for Joule's equivalent and for the value of the ohm; and states that he is about to communicate results of measurement of the mechanical equivalent of heat which are based upon an electrical method.—*Phil. Mag.*, April, 1880, p. 237. J. T.

11. *Velocity of Electricity in the Electric Current.*—BOLTZMANN discusses the new discovery in magnetism made by Mr. E. H. Hall, of the Johns Hopkins University, and shows that the absolute velocity of a current of electricity in a conductor can be determined by the employment of the method described by Hall. It is also shown that the general equations of Kirchhoff, Weber, Helmholtz, Maxwell and Stefan for the motion of electricity in conductors should be modified so as to embrace a new term which expresses the electro-dynamic action discovered by Hall.—*Kais. Akad. der Wiss. in Wien*, Jan. 15, 1880, p. 11. J. T.

12. *Measurements of Gravity at Initial Stations in America and Europe.* 145 pp. 4to. Washington, 1879. (U. S. Coast Survey, C. P. Patterson, Superintendent. Methods and Results—Appendix No. 15, Report of 1876.)—This paper forms the first part of the report by Mr. C. S. Peirce on the measurement of the acceleration of gravity at initial stations in America and Europe. It includes the discussion of the observations made with a Bessel reversible pendulum and of the large number of corrections required in obtaining the true result. The observations were obtained with the same pendulum, swung at the following stastations: Geneva, Paris, Berlin, Kew and Hoboken. By this means the observations in America are connected immediately with those of the most important stations abroad, where the chief absolute determinations have been made and from which pendulum expeditions have been sent out. The station at Hoboken thus becomes the initial station for this continent. Similar action has been in part followed by European surveys, Switzerland and Austria having already swung their standard pendulums at Berlin; this is in compliance with the plan adopted at the meeting of the International Geodetic Congress in Paris in 1875.

II. Geology and Mineralogy.

1. *Geological Survey of Pennsylvania. The Permian or Upper Carboniferous Flora of West Virginia and Southwest Pennsylvania;* by Wm. A. Fontaine, Prof. Geol. Univ. of Virginia, and I. C. White, Professor Nat. Hist. Univ. West Virginia and Assistant Geologist on the Geological Survey of Pennsylvania. 144 pp. 8vo, with 38 plates.—The authors derive, from the study of the plants of the "Upper Barren" Coal Measures of Pennsylvania and Virginia, that this part of the so-called Carboniferous formation, is Permian in its relations. The species determined belong to the genera *Equisetites*, *Calamites*, *Nematophyllum*, *Sphenophyllum*, *Annularia*, *Sphenopteris*, *Neuropteris*, *Odontopteris*, *Callipteris*, *Callipteridium*, *Pecopteris*, *Goniopteris*, *Cymoglossa*, *Alethopteris*, *Tæniopteris*, *Rhacophyllum*, *Caulopteris*, *Sigillaria* (two species), *Cordaites*, *Rhabdocarpus*, *Carpolithes*, *Gulielmites*, *Saportæa*, *Baiera*. The following are part of the proofs of Permian age which the authors present. Out of 107 species found in the Upper Barrens of West Virginia, 22 occur in the Coal Measures proper, while 28 (including 16 of the preceding 22) are European Permian species. Of the 28, 12 have never been found in the Coal Measures of the United States, and two, *Callipteris conferta* and *Alethopteris gigas*, are exclusively Permian. Again, *Odontopteris obtusiloba* is a characteristic Permian plant. The genus *Baiera*, which first appears abroad in the Permian, has a species *B. Virginiana*, differing chiefly in greater size and robustness from the Permian *B. digitata*. There are no *Lepidodendra*. *Alethopterids* and *Odontopterids* are rare (two of the former and four of the latter); nearly all the *Pecopterids* have the arborescent character which characterizes Permian

species; and the *Neuropterids* and *Sphenopterids* show Permian features. Further, the occurrence of Conifers of the genus *Saportæa*, allied to *Salisburia*, favors the view sustained, as this type which made its appearance in the Permian, has great prominence in the Jurassic.

The evidence from the animal fossils is feeble, as there is little of it, but none opposes the idea of a Permian age.

Above the Pittsburg Coal, and its associate coals, the Redstone and Sewickley there are two marked stratigraphical horizons. One is that of the limestones between the Sewickley and Waynesburg coal-beds; in the shales accompanying the latter there occur nearly all the characteristic Carboniferous plants of the Upper Barrens, but mixed with many new forms. The other is that of the overlying Waynesburg sandstone, much of it very pebbly. Only about twenty per cent of the species existing below this sandstone pass above it; and coal-beds become very thin above and gradually disappear. "This is what we should expect *a priori* if we should regard the Permian, not as a distinct formation, but as the close of the Carboniferous," as sustained by "the investigations of Weiss, Grand 'Eury and others." The first of the above horizons marks the transitions from the Carboniferous to the Permian.

The conclusion of the authors appears to be well sustained; and, as they state, it places the "great Appalachian Revolution" "at the close of the Permian Period" and explains "the absence of Permian beds from the Mesozoic areas of the eastern portion of the Continent and the Triassic age of the oldest beds there found."

2. *Geology of Wisconsin:* Survey of 1873 to 1879. Vol. III, accompanied by an Atlas of Maps. Published under the direction of the Chief Geologist, J. C. CHAMBERLIN, by the Commissioners of Public Printing. 764 pp., 8vo, with many plates, maps and sections. 1880. — This volume of the final report on the Geology of Wisconsin treats of the general geology of the Lake Superior region, including Northern Wisconsin, and then, in its several chapters, of the topography, special geology and lithology. The rocks, with the exception of the Cambrian beds, are referred to the Laurentian, the Huronian and the Keweenawan or Copper-bearing systems, and the last, as well as the others, is made pre-Cambrian. Professor R. D. IRVING reports on the general geology, and geology of the Eastern Lake Superior district; R. PUMPELLY, on the lithology of the Keweenawan system; A. A. JULIEN, on some rocks of Ashland County; C. E. WRIGHT, on the Huronian series of Penokee Gap, (including the Penokee iron range) and on the Menominee iron region; E. T. SWEET, on the Western Lake Superior district; T. C. CHAMBERLIN, on the Upper St. Croix district, from the notes of the late MOSES STRONG; T. B. BROOKS, on the Menominee region; A. WICHMANN, on the microscopic character of the Huronian rocks of the Iron region. The volume contains many maps, sections

and plates on microscopic lithology, distributed through the text, and is accompanied by an atlas of large, colored, geological maps. It bears evidence throughout of careful study. It is especially important for its illustrations of Archæan formations; its detailed lithological descriptions of the various crystalline rocks, based largely on microscopic investigations; and, economically, for its reports on the iron ore regions and their ores and mines, and on the Keweenaw copper region. It also contains various observations on Quarternary deposits, terraces and erosion.

3. *Palæontology of New York.* Vol. V. Part 2, containing descriptions of the Gasteropoda, Pteropoda and Cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups, by JAMES HALL, State Geologist. Text, 492 pp. 4to, with a 4to volume of 120 lithographic plates. Albany, N. Y. 1879.—This new volume of Prof. Hall's great work will be gladly welcomed by all students in American Paleontology. Albertypes from the drawings of a large part of the plates, together with others of Crustacea, 130 in all, were issued, without descriptions, in a volume in 1877, and a notice of the same was given in volume xiv of this Journal (p. 493).

This *second* part of volume V, now published, will soon be followed by Part I, which treats of the Lamellibranchiata; 80 plates have already been printed. The preface to the volume also states that the descriptions and plates of the Corals, Bryozoans, Brachiopods and Crustaceans of the Upper Helderberg and Hamilton groups are far advanced, over 60 plates illustrating these subjects being finished and a large part already printed. Besides, the manuscript of the Corals and Bryozoa of the Lower Helderberg is ready, and the twenty-two plates are completed and printed. Further, over 800 other drawings of corals have been made for the final illustration of this class of fossils. These statements show that great progress has been made toward the completion of the New York Paleontology.

4. *Report on the Geological Survey of New Jersey for the year* 1879; by the State Geologist, Professor G. H. COOK.—This report contains new facts relative to some of the geological formations of New Jersey, and also with regard to the iron ores, soils, clays, waters, and other points of economical importance. It states that the number of opened mines of magnetite in the New Jersey Archæan is now nearly 200, and that they could supply a million of tons annually. The Triassic formation at the Belleville quarries has afforded remains (the "decorticated trunk") of a fossil plant which, according to Professor Lesquereux, resemble much the *Lepidodendron Weltheimianum*, a species of the Devonian and Subcarboniferous. Very positive evidence will be required to make it certain that it is this old species, or any species of *Lepidodendron*. Professor Cook states that the sandstone of the "southeastern margin of the formation contains mostly grains of feldspar instead of quartz," as if made from a very feldspathic gneiss or granite, such as is found in great quantities on that side

of the formation; "while the rock of the northwestern side contains fragments of magnesian limestone," a rock occurring in the older formations near by on that side. The exposure of Silurian magnesian limestone within the area of the sandstone, and other facts are stated to favor the view of a comparatively small thickness for the formation.

The report is accompanied by a handsome colored geological map of the State.

5. *Note on the occurrence of fossils in the Triassic and Jurassic beds near San Miguel in Colorado;* by R. C. HILLS.—The fossiliferous portion of the Triassico-Jurassic beds of the Upper San Miguel is situated in lat. 37° 58′ N., long. 107° 50′ W., near the town of San Miguel city, and extends east from that point along the flank of San Miguel park about two and a half miles. The fossils occur in the upper portion of the red sandstone beds and are confined to two strata, aggregating about fifty feet in thickness. The lower stratum, in which the Pterophyllum was found, is a fine-grained micaceous red sandstone with a schistose cleavage. It often shows mud-cracks and raindrop pits, also casts, such as might be caused by a large animal reclining upon moist sandy material.

The upper stratum is made up of small pebbles mostly calcareous. Fragments of teeth are very abundant in this stratum, with an occasional fragment of bone and short flattened tree trunks showing upon the surface numerous small warty protuberances and right lines from one and a half inches to two inches apart. These trunks are from three feet to five feet long and taper rapidly from the base. Fishes near *Belodon priscus* and *Catopterus gracilis* occur in this stratum; but, as the coarse material of which it is composed is not adapted to receive and retain delicate impressions of perishable forms, the occurrence of the last named fossil will probably be restricted to places where small depressions favored the deposition of finer sediment. This bed underlies and is conformable with a second series of rocks having from twenty feet to forty feet of bituminiferous limestone at the base, followed by a few feet of hornstone and several hundred feet of gray sandstone. I have not observed any fossils in this series, which is unconformable with the Cretaceous and may be Jurassic. As might be expected, a thin stratum of white sandstone underlies, in some places, the bitumeniferous limestone.

The rock of the lower portion of the red sandstone series are often shaly and readily separable into fragments of conchoidal fracture.

The erosion has not been sufficient to reveal the thickness of these beds, but it is not less than 1,000 feet.

A good section of these rocks is showed upon the Animas where they extend for six miles along the river between Hermosa and Animas City, upon the Dolores near Rico, on the Uncompahgre below Ouray and less extensively on nearly every stream tributary to the Animas and San Juan.

6. *Note on Sauranodon;* by O. C. MARSH.—The name Sauranodon, given by the writer to a genus of Jurassic reptiles, appears to have been previously used in the same class by Jourdan. If thus preoccupied, it may be replaced by the name *Baptanodon*, for the extinct generic form, with *Baptanodontidæ* for the family, and *Baptanodonta*, for the Suborder represented.

May 20, 1880.

III. BOTANY AND ZOOLOGY.

1. *Revision of the Genus Pinus, and Description of P. Elliottii;* by Dr. GEORGE ENGELMANN. St. Louis, 1880. Separately issued from the Transactions of the Academy of Science of St. Louis, vol. iv, no. 1, pp. 161–190 (1–30), but printed in folio, to match the plates, 1–3.—The plates, illustrating *Pinus Elliottii* Engelm., are very fine, having been excellently drawn from nature on stone by Paul Roetter, and they give the whole port, structure and germination of this the handsomest species of our Atlantic States. In appearance it is as it were intermediate between *P. Tæda* and *P. australis*. The characters of the Pines and a sketch of former arrangements are surveyed in detail; the anatomy of the leaves is particularly attended to, and the character of the resin-ducts is turned to account as a very important subsidiary mark of affinity. The primary sections of the genus are reduced to two, founded mainly on obvious differences in the scales of the cones, viz: *Strobus*, with marginal unarmed umbo (divided into *Eustrobi* and *Cembræ*), and *Pinaster*, with dorsal and mostly armed umbo. Then the subdivisions are distinguished by the position of the ducts within the leaf, "whether peripheral, parenchymatous, or internal;" then the position of the female ament and cone, whether subterminal or lateral; and finally the number of leaves in the fascicle is taken into consideration in the second section; the first consisting wholly of five-leaved species. Although only such species and subspecies are enumerated as the author has himself examined, yet the list is almost complete.

P. albicaulis of California is reduced to a subspecies of *P. flexilis*, a marked one certainly, as to the cones; and *P. Balfouriana* of California (now re-discovered on the slope of Shasta) is considered to include the Rocky Mountain *P. aristata*. *P. ponderosa*, after long study, is still left to include extreme forms. *P. Banksiana*, being a year earlier than the name *P. rupestris* of Poiret, is retained for the species. A second Cuban species is characterized from C. Wright's collections, and is named *P. Wrightii*, but male flowers have not been seen. It is suggested that the fine *P. Elliottii*, here so admirably illustrated, may not be wholly distinct from *P. Cubensis*.

The size of the pollen-grains is given for most of our species. Their lightness and power of floating a long time in the air, and therefore of transportation by the wind, are shown in the statement that pine-pollen has been found in the streets of St. Louis, after

a rain-storm from the south, in March, when no pines north of Louisiana were in bloom, and which must have come from the forests of long-leafed pine on Red River, over about 6½ degrees of latitude or 400 miles in a direct line. Let us congratulate Dr. Engelmann upon his satisfactory completion of his prolonged investigation of our *Coniferæ*. A. G.

2. *Methodik der Speciesbeschreibung, und Rubus: Monographie der einfachblättrigen und krautigen Brombeeren*, etc. . . . von Dr. Otto Kuntze. Leipzig, Felix, 1879. 160 pp. 4to, with a lithographic plate and seven statistic-phytographical tables. —A most elaborate discussion, first of the diversity of value and indefiniteness of botanical species, followed by a plan for a better presentation of botanical relationship; next an application of the new "speciesbeschreibung" to the simple-leaved *Rubi*. The author sets out with the proposition—in one sense true—that Darwin on one hand and Jordan on the other have shattered to the foundation the Linnæan conception of species; but that this conception still fetters systematic botany; that the plan of describing only typical forms, or what we choose to consider such, is a deliberate negation of existing facts; and that to follow the rules of arranging related forms under the successive stages of species, subspecies, varieties, subvarieties, etc., has become incompatible with a strict and faithful following of nature. He insists that the monographer should describe all the forms, and arrange them according to their relationship, which arrangement, if successful and true, will bring to view their probable genealogy.

Rosa, *Rubus*, and *Hieracium* in the Old World, *Lupinus* and *Potentilla* in North America, are among the genera which countenance this view, and are the despair of systematists. If most botanical genera were like them, we should all be driven to conclusions like those which Dr. Kuntze perhaps too hastily or too absolutely propounds. But in our opinion, the Linnæan conception and the Linnæan practical treatment of species are quite capable of being worked with advantage and fair success under the idea of relative instead of absolute fixity of character; and we are confident that, if abandoned, we shall not in our day find anything so good to put in their place. We seem to need re-adaptation rather than reconstruction; and we fear that Dr. Kuntze's plan of treatment will diffuse the difficulties over a wider surface rather than obviate them. Of course the idea of disposing the forms according to supposed genetic relationship is most proper and scientific; but that is the attempt and ultimate aim now-a-days in all natural history; and so far as it can be done at all, may be as well accomplished under the received taxonomy as under our author's scheme. Not that we would depreciate the value of such a treatment as he has given to a part of the genus *Rubus*, or doubt that "collective species" may be advantageously so discussed, in spite of the formidable number of confessedly indefinite terms which are found necessary.

For example, to designate grades of forms in this genus, we have

first a general division into *Finiformes* and *Gregiformes;* the former being those which appear to have no very near surviving relatives, i. e. they are very well marked and moderately varying species. Those with numerous variations within a common type are *Gregiformes;* and these again may be distinguished as *Locoformes, Typiformes, Versiformes, Ramiformes, Avoformes, Medioformes, Mistoformes, Singuliformes,* and a few more,—terms which we have not space to define, which indeed are not to be really defined, and nearly all of which involve hypotheses. An application of them is seen in the suggested derivation of *Dalibarda repens* from *Rubus nivalis!*

Moreover, Dr. Kuntze proposes to use arbitrary signs in place of language in botanical descriptions, which give to botanical characters the aspect of mathematical formulæ. To us all this is most repulsive. In the preface botanists are requested, in case they do not approve these schemes, to turn their endeavors towards bettering them. But as yet they are hardly shut up to the alternative. Slight betterments of the old paths from time to time, as need appears, may be more serviceable than doubtful labor upon new and untrodden roads. A. G.

3. CHARLES CHRISTOPHER FROST, the oldest cryptogamist in this country, died at Brattleboro, Vermont, March 16, 1880. He was born in the same town Nov. 11, 1805, and lived there throughout his long life. His father was a shoemaker, which trade his son learned in his youth, afterward becoming a dealer in boots and shoes, and he continued in this business until his death. He received a common country-school education; but in the leisure hours snatched from his business, he devoted himself to scientific pursuits and mastered, unaided, the Latin, French, and German languages, for the purpose of studying works upon Natural History. He was a born naturalist, loving Nature for herself and not for the fame or position he might attain by the publication of his investigations. There was scarcely a branch of scientific study which he did not pursue to some extent. He explored the country about him exhaustively, collecting everything in the domain of natural science; but he was best known to the world as a student of Cryptogamic Botany, and was a life-long correspondent of the celebrated cryptogamists of his time. He amassed a large collection of species of natural history and was the author of numerous species in his favorite specialty, the Fungi. He communicated various papers to the publications of his day; but his most important contribution to science is a List of the Mosses, Liverworts, Charas, and Fungi, in the "Catalogue of plants growing within thirty miles of Amherst," published by Professor Edward Tuckerman and himself in 1875. C. J. S.

III. Astronomy.

1. *Elements of the Comet discovered by J. M. Schæberle at the Ann Arbor Observatory on the 6th of April.* Letter to the editors from Mr. Schæberle, dated Ann Arbor, Mich., May 18, 1880.—As there is no ephemeris published of the comet which I discovered on April 6, and as it is quite probable that observations can still be made with large instruments, as soon as the moon gets out of the way, I send you the ephemeris below for publication in the American Journal of Science.

An approximate orbit was first computed from Ann Arbor observations of April 6th, 12th and 20th. The large perihelion distance as shown by the resulting elements induced me to lengthen the interval of time between the extreme dates. An orbit was then computed from the following data; the times of observation and the places of the comet being corrected for aberration and parallax respectively:

	Ann Arbor Mean Time.	App. α.	App. δ.
April 6, 1880,	$15^h\ 56^m\ 30^s$	$7^h\ 12^m\ 30^s{\cdot}40$	$84°\ 24'\ 2{\cdot}1''$
April 20, 1880,	11 52 11	6 16 37·65	73 51 59·3
May 4, 1880,	9 14 11	6 15 47·66	64 55 27·3

The resulting elements I find to be

T = June 30·7964 Washington mean Time.
$\pi = 41°\ 51'\ 27''{\cdot}8$
$\Omega = 257\ \ 9\ \ 48{\cdot}5$ } Ecliptic and mean Equinox 1880·0.
$i = 123\ \ 5\ \ 29{\cdot}8$
$\log q = 0{\cdot}259736$

The residuals for the middle place are

	Co.—Ob. $\Delta\lambda\cos\beta$	$\Delta\beta$
	—1″·9	—3″·9

Ephemeris for Washington Mean Midnight.

1880.	App. α.	App. δ.	log. γ.	log. Δ.	Intens'y of light
May 24.5	$6^h\ 25^m\ 9^s$	$54°\ 51''{\cdot}4$	0·27404	0·39795	0·79
28.5	6 27 23	53 10 4	0·27122	0·40503	0·77
June 1.5	6 29 39	51 34·5	0·26869	0·41154	0·76
5.5	6 31 56	50 3·2	0·26645	0·41746	0·75
9.5	6 34 12	48 36·1	0·26452	0·42276	0·74
13.5	6 36 27	47 12·7	0·26291	0·42740	0·73
17.5	6 38 39	45 52·6	0·26162	0·43138	0·72
21.5	6 40 47	44 35·5	0·26066	0·43469	0·71

The corrections to the times, for aberration, are still to be applied. The intensity of the light of comet for April 6, is taken as the unit of measure. The R.As. will probably not be more than a second or two in error. The declinations may require a correction of two or three minutes of arc, toward the close of the ephemeris. The declinations deduced from the elements of the orbit given in the Circular of the K. K. Ak. in Wien, are largely in error. On May 12 the ephemeris was nearly half a degree out in declination, so that I felt warranted in sending you the ephemeris given above.

IV. Miscellaneous Scientific Intelligence.

1. *National Academy of Sciences.*—The following is a list of papers registered and read at the meeting of the National Academy of Sciences, at Washington, April 20–23, 1880.

Joseph LeConte.—Binocular Vision; Laws of Ocular Motion.

W. Ferrel.—1. Hollow Water-Spouts and Sand-Spouts. 2. Cloud-Bursts.

E. D. Cope.—1. On the Structure of the Vertebrata of the Permian Period.—2. On the Perforations of the Squamosal bone of the Mammalia.

Elias Loomis.—Contributions to Meteorology.

A. S. Packard.—On the Structure of the Brain of Limulus polyphemus.

S. P. Langley.—1. On an Instrument for Measuring Radiant Heat.—2. On the Composition of Colors.

Alexander Agassiz.—The Sea Urchins of the Challenger Expedition.

O. C. Marsh.—Size of the Brain in Extinct Animals.

W. Gibbs.—On New Complex Inorganic Acids.

T. Sterry Hunt.—On the Taconic System in Geology.

F. M. Green, U. S. N.—On the Telegraphic Determinations of Longitude by the U. S. Hydrographic Office.

D. P. Todd.—On the Announcement of the Discoveries of Intra-Mercurial Planets by Telegraph.

Wm. Harkness.—On the Solar Corona.

E. S. Holden.—On the Nebula of Orion.

Theo. N. Gill.—On the Distribution of the Zenopsis Conchifera.

Josiah P. Cooke.—Revision of the Atomic Weight of Antimony.

Cleveland Abbe—Application of Meteorology to the Grasshopper Pest.

Edward S. Morse.—On an Early Race of Man in Japan.

H. M. Paul.—On the effect of railroad trains in transmitting vibrations through the ground as regards its effect on observations in fixed observatories.

Albert A. Michelson.—On the modifications suffered by Light on passing through a very narrow slit.

J. Lawrence Smith—Some remarks on the supposed nature of the Sun's Corona; and, also, On a supposed new Meteoric silicate.

Stephen Alexander.—On some modern developments bearing upon the Nebular Hypothesis and other matters connected therewith, as well as on some previous changes, and miscellaneous notices.

2. *Emmet County Meteorite:* Supplement to the article on page 459, by the author, J. Lawrence Smith.—When my paper was sent to press, the following new facts in connection with this meteoritic fall had not been discovered. I am indebted for them to Mr. Chas. Birge. These additional discoveries, twelve months after the fall, only add to the interest of this phenomenon. Mr. Birge, a few months ago, had been made aware of the fact that a number of boys, herding cattle near a lake about four miles west of Estherville on the day of the fall, reported that when the meteor passed over them, a great shower of what appeared to them hailstones fell, and that the surface of the water was alive with the falling bodies. Three weeks ago (April 15th) the people of that neighborhood began to find, on the freshly burnt prairies, small pieces of meteorites from the size of a pea to one pound in weight; 300 to 500 were thus found; and ten days ago (May 1st) thousands of men, women and children were on the ground daily, and from the meteoric field probably five thousand pieces have already been gathered, making in all a weight of not less than from 60 to 75 pounds.

3. *Statistics on Earthquakes;* by Professor C. G. ROCKWOOD, Jr. (Communicated.)—Professor Dr. C. W. Fuchs, formerly of Heidelberg, but now in Meran, Tirol, Austria, has for the last fifteen years published annual statistics of earthquakes and volcanic phenomena, and has noticed that in his lists America is remarkable for the paucity of shocks reported. This he attributes, and we think rightly, to the lack of information on the subject, rather than to any real scarcity of such events. As he is now proposing to revise his lists, he has presented to the Smithsonian Institution a request for information in regard to American earthquakes, especially for the whole or any part of the period since 1865. He would be thankful for any information on the subject which may be in the possession of American observers, and which may be sent to his address as above.

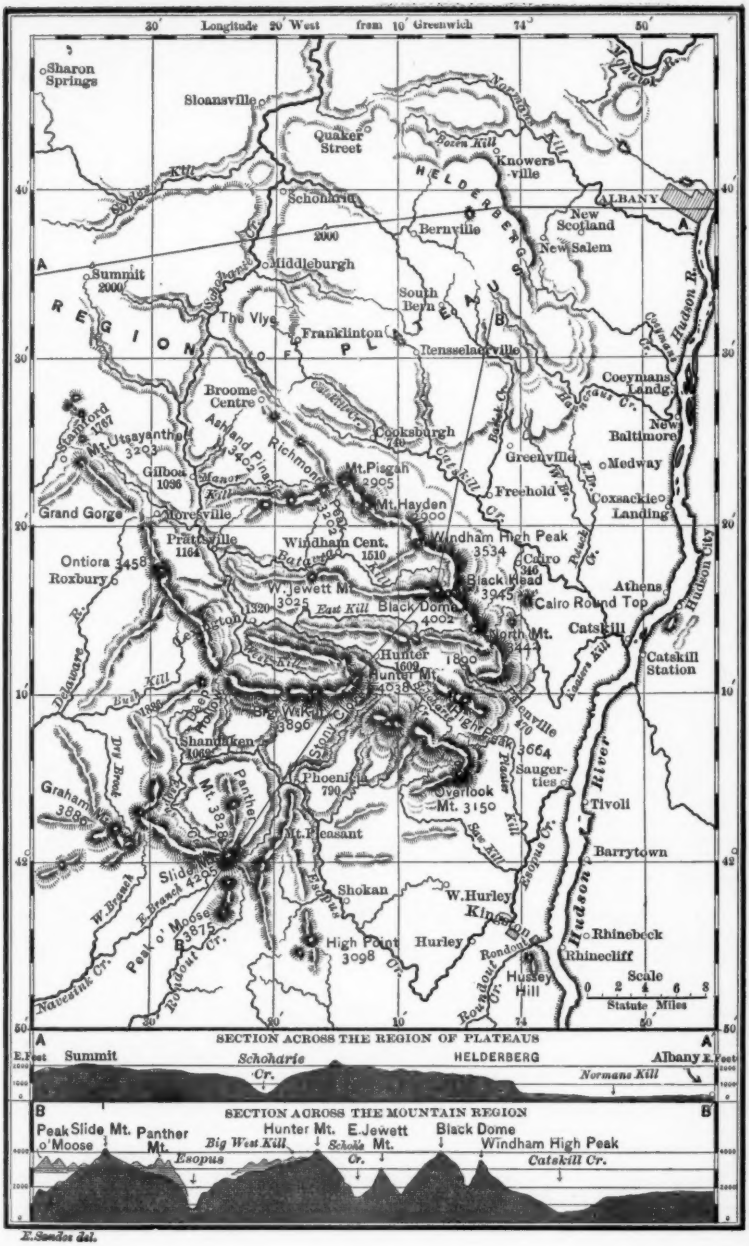
The undersigned, who has for the past eight years been occupied in a similar work in America, would take this opportunity to say to the readers of the Journal, that he also would be very glad to come into communication with other workers in the field of Seismology, either American or foreign. He is especially desirous to obtain correspondents upon the Pacific Coast, who would aid in collecting information in regard to earthquake shocks in that region, where they are so much more frequent than on the Atlantic seaboard.

Princeton, N. J., May 12, 1880.

4. *Tables of the Common Logarithms and Trigonometrical Functions to Six Places of Decimals. With special regard to their Use in Schools.* Edited by Dr. C. BREMIKER. 517 pp. 8vo. New York, 1880. (B. Westermann & Co.).—This reprint of Bremiker's well-known tables is perhaps the very best which has been made accessible to the non-mathematical, scientific and popular public. The arrangement of the figures on the page, both as respects spacing and amount, is that which most quickly guides the eye and conduces to facility in use. The arguments of the logarithms of numbers are given directly to five figures, and the arguments in arc of the trigonometrical functions are given to ten seconds. In both of these respects the tables are superior to those found in current use among the students in our country. Another excellent feature is the addition of a table of Gauss's Logarithms—which would be more widely used if good tables of them were commonly found. The work, both on account of its high reputation for accuracy and its compact convenience, deserves a wider use than it has yet obtained among the very considerable class of students and professional men who have computing to do, but who use inferior tables, or none at all. L. W.

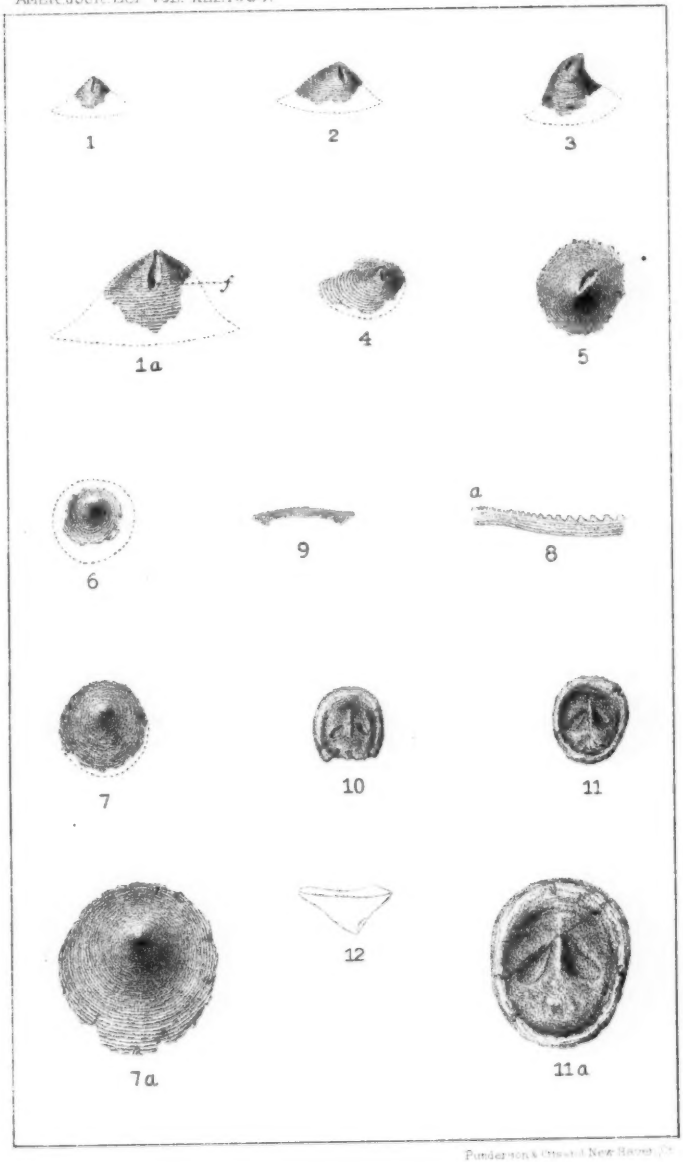
OBITUARY.

Professor WILLIAM H. MILLER, the eminent Crystallographer and Mineralogist of Cambridge, England, has recently died, at the age of seventy-nine.


Longitude West from Greenwich
Sharon Springs
Sloansville
Quaker Street
Knowersville
Schoharie
Schoharie Cr.
Schoharie Kill
Normans Kill
Foxen Kill
HELDERBERG
ALBANY
New Scotland
New Salem
Bernville
Middleburgh
Summit 2000
South Bern
The Vlye
Franklinton
Rensselaerville
PLATEAU
REGION OF
Coeymans Landg.
Coeymans Cr.
Hudson R.
New Baltimore
Greenville
Medway
Freehold
Coxsackie Landing
Broome Centre
Cooksburgh
Mt. Pisgah 2905
Mt. Hayden 2900
Windham High Peak 3534
Windham Cent. 1510
Cairo
Black Head 3945
Cairo Round Top
Athens
Catskill
Catskill Station
Hudson City
Stamford 1967
Mt. Utsayantha 3203
Gilboa 1036
Grand Gorge
Moresville
Prattsville 1164
Ontiora 1458
Roxbury
Ashland Pinnacle 3400
Manor Kill
Richmondville
Cadiz Cr.
Cats Kill
Batavia Kill
Black Dome 4002
North Mt. 3442
W. Jewett Mt. 3025
East Kill
Hunter 1609
Hunter Mt. 4038
Kaaterskill High Peak 3664
Overlook Mt. 3150
Saugerties
Tivoli
Barrytown
Rhinebeck
Rhinecliff
Hudson River
Delaware R.
Big Indian Cr.
Shandaken 1068
Graham Mt. 3860
Panther Mt. 3829
Phoenicia 790
Mt. Pleasant
Slide 4205
W. Branch
E. Branch
Peak o' Moose 3875
Shokan
W. Hurley
Kingston
Hurley
High Point 3098
Rondout Cr.
Hussey Hill
Esopus Cr.
Esopus
Natrestink Cr.
Scale
0 2 4 6 8
Statute Miles
SECTION ACROSS THE REGION OF PLATEAUS
A
Summit
Schoharie Cr.
HELDERBERG
Normans Kill
Albany
E. Feet
SECTION ACROSS THE MOUNTAIN REGION
B
Peak o' Moose
Slide Mt.
Panther Mt.
Hunter Mt.
Big West Kill
E. Jewett Mt.
Schoh. Cr.
Black Dome
Windham High Peak
Esopus
Catskill Cr.

E. Sandes del.

LAKE ONTARIO
ADIRONDACK PLATEAU
Black R.
Edge of the Plateau
Mohawk R.
Genesee R.
PLATEAU OF NEW YORK
Schoharie
Albany
Catskill Cr.
CATSKILL MTS.
Hudson R.
Green Mountains
Chemung R.
Rondout
Delaware R.
Port Jervis
Shawangunk
Allegheny R.
Alleghany Mountains
Wyoming Mts.
New York
Juniata R.
Blue Ridge
Trenton
Susquehanna R.
Philadelphia
Delaware R.
South Mts. or
ATLANTIC OCEAN
Potomac R.
WASHINGTON



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